RU635

MAR

4251

Ecological Research Associates

FISH DISTRIBUTION AND USE OF NEARSHORE WATERS IN THE NORTHEASTERN CHUKCHI SEA

PREPARED BY:

LGL ECOLOGICAL RESEARCH ASSOCIATES, INC.
1410 CAVITT STREET
BRYAN, TEXAS 77801

PREPARED FOR:

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
OMPA/OCSEAP
P.O. BOX 1808
JUNEAU, ALASKA 99802

AUTHORS:

R.G. FECHHELM
P.C. CRAIG
J.S. BAKER
B.J. GALLAWAY

FEBRUARY 1984

FISH DISTRIBUTION AND USE OF NEARSHORE WATERS IN THE NORTHEASTERN CHUKCHI SEA

FINAL REPORT

Prepared by

R.G. Fechhelm
P.C. Craig
J.S. Baker
B.J. Gallaway

LGL Ecological Research Associates, Inc.
1410 Cavitt Street
Bryan, Texas 77801

Prepared for

National Oceanic and Atmospheric Administration
OMPA/OCSEAP
P*O. Box 1808
Juneau, Alaska 99802

February 1984

TABLE OF CONTENTS

TABLE OF CONTENTS (cent'd)

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cent'd)

TABLE OF CONTENTS (cent'd)

LIST OF FIGURES

LIST OF FIGURES (cent'd)

LIST OF TABLES

LIST OF APPENDICES

ACKNOWLEDGEMENTS

We express our thanks to Robert Dillinger, William Griffiths, Dale Herder, Randall Howard, Larry Martin and David Schmidt for their help and expertise in collecting the field data; Robert Dillinger and Nell Stallard for laboratory analyses and identification regarding stomach analyses; Jean Erwin and Mardi Gazey for assisting in the manuscripts preparation; and Janice Fechhelm for graphics.

Additional thanks are extended to the people of the village of Point Lay whose help and hospitality were invaluable to their success of the summer program.

This study was funded by the Minerals Management Service through interagency agreement with the National Oceanic and Atmospheric Administration as part of the Outer Continental Shelf Environmental Assessment Program.

1.0 INTRODUCTION

As part of the U.S. government's continuing desire to develop economically important natural energy reserves, the Department of the Interior recently authorized a lease sale which will permit industry to initiate petroleum exploration operations in the northeast Chukchi Sea. Scheduled to commence in February 1985, the 'Barrow Arch No. 85" sale will open approximately 28 million acres of continental shelf to private development (Fig. l-l). The proposed lease area is tentatively defined as north of 68.4°N latitude and south and west of a line that starts at a point where 71°N latitude intersects the coastline west of Barrow, then moves west to 162°W longitude, then north; the western boundary is at about 169°W longitude at the U.S.-U.S.S.R. 1967 Convention Line.

Offshore petroleum exploration and production operations pose a wide array of potential hazards to the well-being of the marine environment. The coastal waters of the Chukchi Sea are of particular environmental interest because they are an important part of the ecosystem supporting some of northern Alaska's fish, bird and marine mammal populations. Concern over maintaining the ecological integrity of the Chukchi system in the face of impending commercial operations prompted the National Oceanographic and Atmospheric Administration's Outer Continental Shelf Environmental Assessment Program (NOAA/OCSEAP) to initiate a detailed investigation of regional resources.

In the fall of 1982 LGL Ecological Research Associates, Inc. (LGL) was awarded a contract to conduct a single year study of the fishes of the northeast Chukchi Sea. LGL's investigation focused primarily on arctic fish usage of and ecological dependence on marine and estuarine environments. The study consisted of ship- and land-based synoptic fish surveys at a variety of locations along the NE Chukchi Sea coast from Peard Bay to Point Hope. Data were collected for the most part during the open-water, summer season and to a lesser extent in winter. Additional data regarding jig-fishing surveys near St. Lawrence Island and Kotzebue were also included.

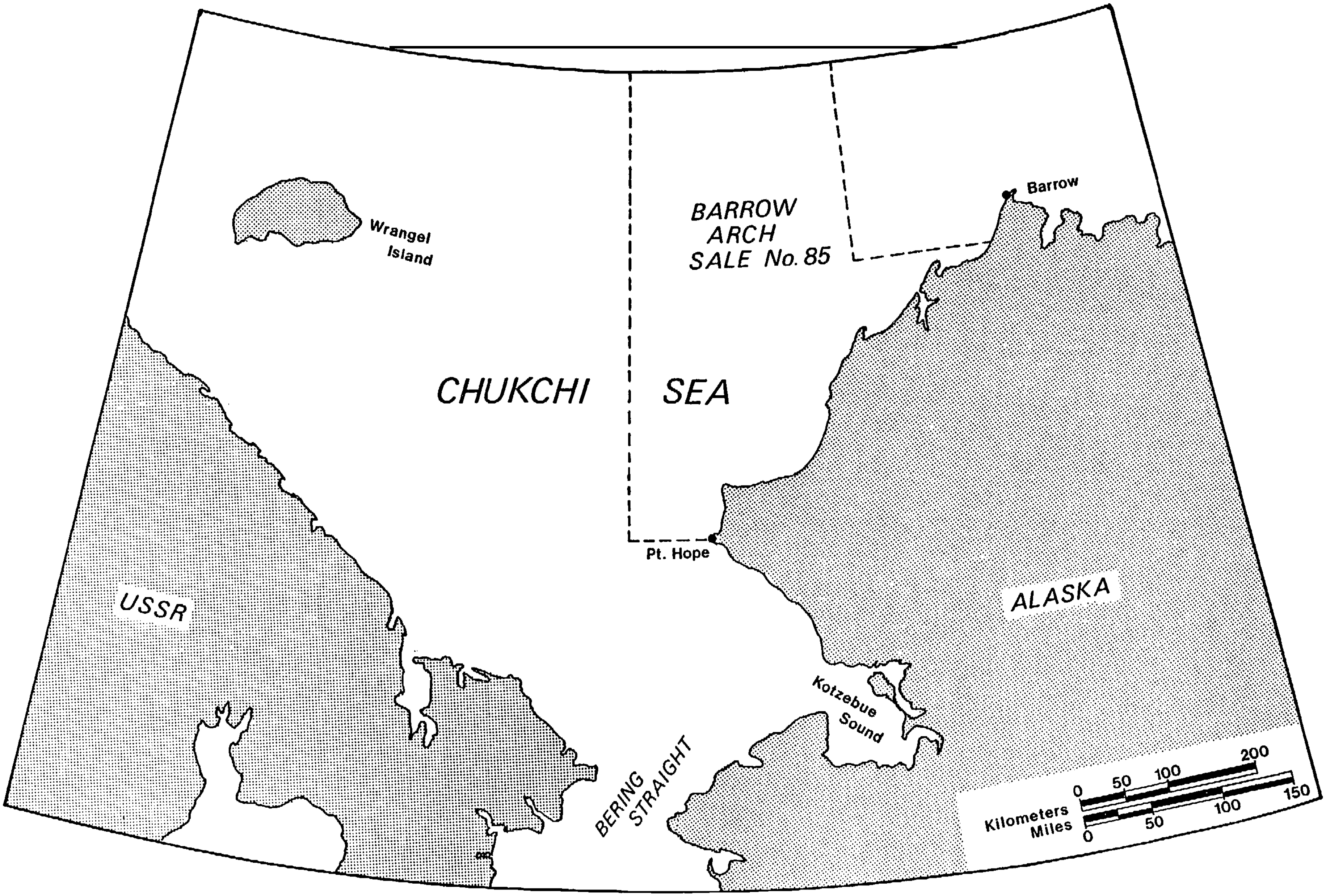


Figure 1-1. Lease area covered by “Barrow Arch Sale No. 85”.

This report contains the results and interpretation of fish data gathered during the 1983 study. It provides an appraisal of fish community structure along the northeast Chukchi Sea coast and offers an initial assessment of fishery vulnerability to upcoming petroleum production operations.

1.1 Rationale and Scope

The 1983 study was designed to examine marine and anadromous fish usage of a variety of habitat types and geographic locations in the northeast Chukchi Sea and to incorporate these findings into a comprehensive profile of regional fishery processes. Results further served as an information base for assessing fish community vulnerability to the proposed Barrow Arch development.

While the overall study area encompassed both nearshore and offshore locations, a great deal of emphasis was placed on the survey of nearshore waters. This decision stemmed from numerous studies conducted in the Beaufort Sea as a result of that regions extensive oil and gas development. These investigations have demonstrated nearshore zones to be an important habitat supporting a number of arctic fish species (Bendock 1977, Craig and Griffiths 1981, Craig and Haldorson 1981. Furniss 1975. Griffiths and Gallaway 1982, Griffithset al. 1983). Nearshore waters serve as principal migratory pathways for anadromous fish such as ciscoes, char, whitefish and salmon, and as summer feeding grounds for both anadromous and marine species. The nearshore emphasis was further supported by the fact that the petroleum industry will probably be technologically restricted to nearshore areas during the initial phase of exploration and development.

In view of the fact that the Chukchi coastline is long and has a variety of topological features, the study area was divided into four major habitat components--Peard Bay, Wainwright Inlet, Kasegaluk Lagoon and Ledyard Bay (Fig. 1-2). Each locale was presumably characterized by distinctive patterns of fish usage and provided some measure of geographic representation. Field investigations comprised three major sampling efforts. Under-ice fyke netting and gill netting surveys were conducted at each of the four locations during 15-28 March 1983. Kasegaluk Lagoon,

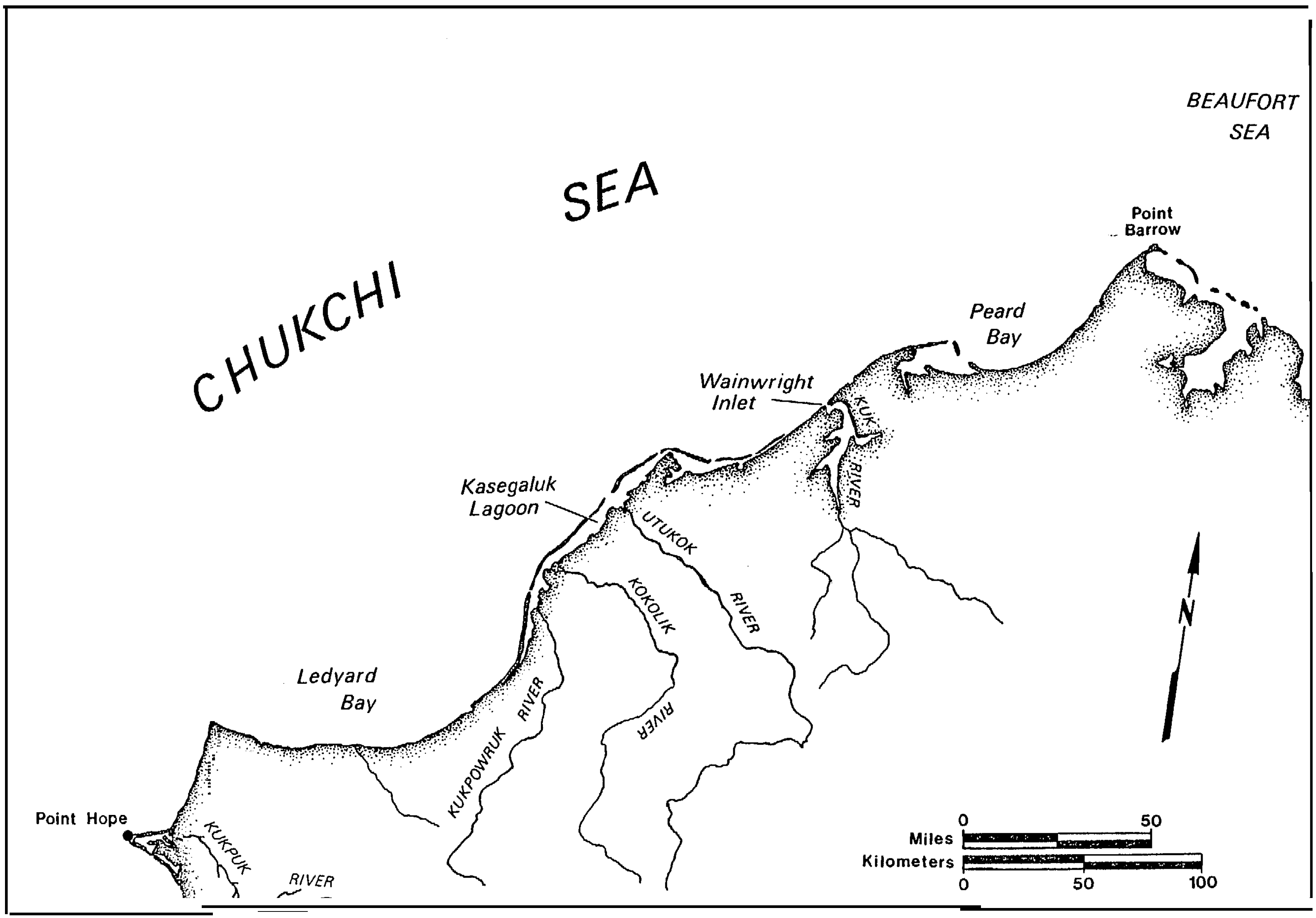


Figure 1-2. Northeast Chukchi Sea coastline.

the most prominent estuarine system on the Chukchi coast, was chosen as the site of more intensive summer study. Synoptic gill and fyke net surveys were conducted in the vicinity of the village of Point Lay primarily during two two-week periods--17 July-4 August and 15 August-1 September. Finally, operations based aboard the NOAA research vessel Discoverer employed gill nets and otter trawls to sample nearshore and offshore waters at Point Lay (Kasegaluk Lagoon), Wainwright Inlet and Ledyard Bay during the period 27 August to 12 September. Two additional otter trawl samples were taken off the west coast of the Lisburne peninsula.

1.2 Objectives

Specific objectives of this study were to:

1. Assess the distributions, habitat dependencies, trophic interactions and life histories of marine and anadromous fishes occupying the nearshore waters of the northeast Chukchi Sea during open-water and winter periods. Special emphasis should be placed on subsistence harvested and tropically important nearshore species.
2. Describe geographic areas or behavioral patterns which appear critical in the feeding, overwintering, spawning, rearing and subsistence use of nearshore fish species.
3. Compare patterns of nearshore habitat use by fish in the northeast Chukchi Sea with those occurring in nearshore regions of the Beaufort Sea, the southern Chukchi Sea and the northern Bering Sea.
4. Determine the vulnerabilities of nearshore fish in the northeastern Chukchi Sea to impacts from OCS oil and gas development.

2.0 CURRENT STATE OF KNOWLEDGE

The status of information regarding the fishes of the Chukchi Sea has recently been reviewed by Bowden and Moulton (1981), Morris (1981), Moulton and Bowden (1981), and Craig and Skvorc (1982). Unlike the Beaufort Sea, whose physical and biological processes have undergone intensive scrutiny because of petroleum exploration and development activities, the Chukchi Sea has received comparatively little attention. Most sampling efforts in this area have been directed toward the more southerly waters of Hope Basin ahnd Kotezbue Sound.

Fisheries data between Point Hope and Point Barrow are sparse and often of a secondary nature. The database for offshore waters is limited to trawl surveys in Ledyard Bay (Alverson and Wilmovsky 1966; Quast 1972, 1974) and near Barrow (Frost et al. 1978). Coastal information consists of species caught at Wainwright and Point Lay (Craig and Schmidt 1982) and in a kelp bed at Peard Bay (Mohr et al. 1957). Similarly, information on anadromous fishes in rivers flowing into the northern Chukchi Sea is limited to brief surveys (Hablett 1979. Bendock 1979, Bendock and Burr 1980). Incidental fisheries data are available for the Barrow region (Murdoch 1884, 1885; Cohen 1954; MacGinitie 1955; Wohlschlag 1956; McPhail 1966) and an under-ice location 400 km northwest of Barrow (Walters 1961). Additional information can be derived from papers describing subsistence fishing patterns at coastal villages (Wilmovsky 1956, Ivie and Schneider 1979, Schneider and Bennett 1979, Pedersen 1979, Pedersen et al. 1979) and the feeding habits of seabirds at Cape Lisburne (Schwartz 1966; Springer and Roseneau 1978, 1979).

Virtually all fisheries data available for the northeast Chukchi Sea have been gathered during the open-water season. The exceptions are winter data collected in 1959-1960 at a floating ice station located 400 km northwest of Barrow (Walters 1961) and an assortment of information about subsistence fishing, including some winter information (Murdoch 1884, 1885; Wilimovsky 1956; Ivie and Schneider 1979; Schneider and Bennett 1979; Craig and Schmidt 1982).

The above-mentioned research has, to date, identified 41 species of fish from the northeast Chukchi Sea (Morris 1981). The most abundant marine species are Arctic cod, starry flounder, Pacific halibut, saffron cod, Pacific herring, capelin and sculpin. Important anadromous species include pink and chum salmon, Arctic char, ciscoes, whitefish and smelt.

3.0 STUDY AREA

The northeast Chukchi Sea coastline extends for 550 km between Point Barrow and Point Hope (Fig. 1-2). Fronted in most places by bluffs and narrow gravel beaches, this area forms the leading edge of a shallow shelf basin that extends to the East Siberian Sea and down through the Bering Straits.

Nearshore waters of the Chukchi Sea are dominated by warm waters transported north from the Bering Sea which form the North Alaska Current. This current runs parallel to the coast in a northeasterly direction and its influence extends as far as Point Barrow. Under certain meteorological conditions? typically in fall and winter, mean northeast flow of the longshore current may exhibit large flow reversals. The following descriptions were provided by Hachmeister (ASI, pers. comm.) for the 1983 Chukchi Sea Synthesis Meeting.

> "Circulation in the inner shelf of the NE Chukchi, as in the Beaufort Sea, has been shown to be highly influenced by meteorological forcing. The Chukchi differs from the Beaufort, however, in that it exhibits a relatively high velocity (approximately 1.0-1.5 kt) nearshore current which in the summer derives its existence independently of the local wind field. Under certain meteorological conditions this current is observed to reverse from its mean northeasterly direction and flow to the southwest. In the summer of 1981 this current was found to reverse for periods of 5-7 days for 35-45 Percent of the open water period (Wilson et al., 1981). In winter months, Coachman and Aagaard (1981) found these reversed flow conditions 20-40 percent of the time along the Cape Lisbourne inner shelf. The current, whether flowing northeast or southwest, typically follows the bathymetry at depths greater than 20 m and possesses a more wind-driven onshore-offshore component at depths less than 20 m."

This wind driven component plays an important role in governing nearshore hydrographic conditions

"Measurements by Wiseman (1974, 1980) have shown that, when meteorological conditions confine the nearshore warm waters to the coast, temperatures may be as high as 130C with salinities less than 29.0 o/oo in late July. However, as meteorological conditions periodically change and as surface waters are moved offshore. water in the nearshore region is replaced by deeper offshore water and exhibits both reduced temperatures (< 3°C) and increased salinities (> 31 o/oo). Hachmeister (1983) has measured nearshore (out to approximately 20 km) changes in temperature from 6 to 0°C and in salinity from 28 to more than 31 o/00 in less than two days in response to a shift from SW to NE winds."

Peard Bay is located in the northeast sector of the study area where the Chukchi Sea and Beaufort Sea water masses mix. This open embayment stretches from Point Barrow to Point Franklin and includes an exposed coastline as well as Peard Bay proper--a large body of water protected from direct ocean exposure by Point Franklin. The occurrence of a longshore. current-induced, anticyclonic gyre and a kelp community on a rocky substrate (Mohr et al. 1957) has caused speculation that Peard Bay may be the site of increased biological activity.

Wainwright Inlet is an inland body of brackish water lying at the mouth of the Kuk River drainage. It is a summer feeding area and migratory pathway for a variety of fish species and in winter it supports an important subsistence fishery for boreal smelt.

Kasegaluk Lagoon is a prominent coastal feature and is unparalleled in size by the smaller lagoons of the Beaufort Sea. It forms one of the largest estuarine habitats in Alaska's North Slope region. Protected by a continuous chain of offshore barrier islands that extend along 180 km of coastline, lagoon waters receive freshwater discharge from Kukpowpuk, Kokolik and Utukok rivers, as well as from tundra creeks and numerous smaller rivers. Kasegaluk Lagoon is a shallow water basin typically less than 1 m in depth, however, depths of 2-3 m do occur at the northeast end from Icy Cape to Pingovarak Pass. Seaward of the barrier islands ocean depths drop sharply to 2 m within 5-6 m from shore and to 8 m within 50 m from shore. Freshwater discharge, solar heating and the wind-driven intrusion of marine water through the dozen or so barrier island inlets govern lagoon hydrography.

Ledyard Bay represents the southern portion of the study area. With the exception of the Pitmegea River, the long, exposed coastline is devoid of major freshwater drainages. Because of the bay's proximity to the Bering Straits, local physical processes are strongly influenced by the warm waters of the North Alaska Current. The region's most prominent hydrographic feature is a persistent, clockwise gyre which presumably contributes to the productivity of the area.

3.1 Annual Cycle

Ice cover in the Chukchi Sea lasts for about seven to eight months each year. The formation of slush ice begins in September in lagoon and nearshore areas. Landfast ice begins forming in November and slowly builds seaward. By the end of winter ice cover may extend as far as the 20 m contour where it may reach a thickness of 2 m. Shallow nearshore areas and the entire Kasegaluk Lagoon system freeze to the bottom. Pack ice moves into the Chukchi in fall and may consist of multi-year ice fields up to6 m in depth.

The shear zone between landfast and pack ice is dominated by the Chukchi polynya. This open water expanse persists throughout the winter and stretches from Point Barrow south to beyond Cape Lisbourne. The polynya is wider to the southwest because of the warming influence of the Bering and SE Chukchi seas. It attains a width of about 1 km near Barrow by the end of winter.

Warmer temperatures and freshwater runoff in late spring-early summer initiate breakup. During June-July the northeasterly retreat of pack ice and the melting of fast ice widens the Chukchi polynya. Fragmented fast ice is driven offshore by S-SE winds but is occasionally driven back onto beaches when winds blow out of the north or west. A landfall of fragmented sea ice occurred at Point Lay on 21 July and remained for several days. Schmidt and Craig (in press) reported that Kasegaluk Lagoon was virtually ice-free from late June-late September.

3.2 Tides

As in most places along the arctic coast variations in sea level due to lunar tides are rather small, typically 10 cm or less. Storm surges, however, can cause considerable fluctuations in nearshore water levels. A positive storm surge of 40 cm was recorded by Hunkins (1964) and during the period 1962-1973. surge amplitudes have ranged from -1.10 to +1.89 m.

4.0 METHODOLOGY

4.1 Winter Program

Land based synoptic surveys were conducted during 15-28 March at Peard Bay, Peard Bay proper, Wainwright Inlet and Ledyard Bay (Fig. 4-l). Table 4-1 lists the geographic coordinates and sampling periods for each sit e. The single sampling day at Peard Bay proper reflects a variety of mechanical and logistical problems which hampered the start of the field program--this station was the first to reestablished. An attempt was made at establishing a sampling station in Kasegaluk Lagoon near Kukpowruk Pass, however, the effort proved unsuccessful because the entire water column was frozen. Hydrologic data were collected from a point just seaward of Kukpowruk Pass (Fig. 4-l).

Table 4-1. Geographic coordinates and sampling periods for the four winter sites.

Location	Geographic Coordinate	Days Sampled
Peard Bay (proPer)	70°51.3'N 158°49.2'W	1
Peard Bay	70°59.1'N 158°13.2'W	5
Wainwright	70°45.7'N 159°56.5'W	3
Ledyard Bay	69°16.1'N 163°34.2'W	4

Each field site employed one fyke net and one gill net positioned within 100 m of each other. Hydrographic data were collected at each site.

4.1.1 Water Quality

Surface water temperature, surface salinity and surface turbidity were recorded with each daily check of the sampling sites. Temperature

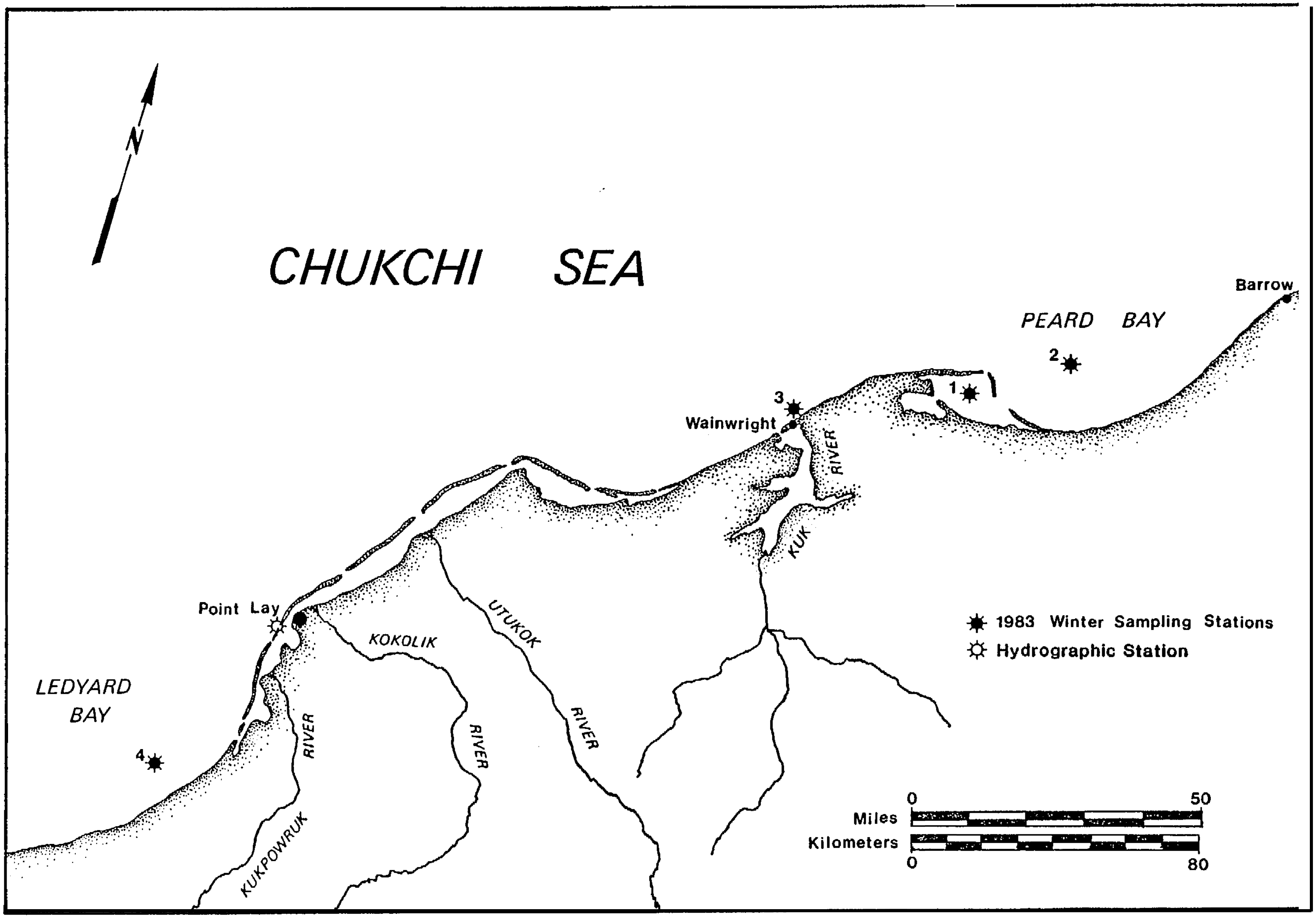


Figure 4-1. Sites sampled during 15-28 March 1983.

was measured in the field with in-glass mercury thermometers. Surface water samples were returned to base camp and analyzed with a YSI-33 Salinity/Conductivity meter (±0.9 ppt above 4.0°C, ±1 ppt below 4.0°C) and a Hach Model 2100 A Turbidimeter [measuring in nephelometric turbidity units (NTU's)]. In addition, vertical profiles of salinity and turbidity were measured once at each station. Water samples taken with a Van Dorn bottle were analyzed in the same method described above for surface samples.

4.1.2 Gill Nets

Monofilament gill nets used during the winter Program were 45.7 m long by 1.8 m deep. Each net was vertically divided into three equally sized panels, with each panel being of a different mesh size (2.54, 3.81 and 5.08 cm stretched mesh). Gill net sets ranged from 20-26 h in duration and were positioned just beneath the prevailing ice layer to sample the upper 1.8 m of water column.

4.1.3 Fyke Nets

The under ice fyke net consisted of four wings, each 100 ft longby 1.8 m deep, eminating from a common 2 m x 2 m x 2 m centralized trap. The wings and trap were constructed of 1.27 cm mesh (stretched) knotless nylon netting. The common sides of any two adjacent wings converged into a 15 cm diameter circular throat which in turn emptied into the central trap. Tne entire device was suspended beneath the ice thus sampling the upper 1.8 m of the water column.

The fyke net was checked every 20-26 h. Because daily catches were low in number all specimens were retained for preservation in a 10% formalin solution. Identification, measurement and life history analyses were subsequently conducted at LGL's Bryan, Texas laboratory.

4.2 Kotzebue and St. Lawrence Island

Since winter data are difficult to obtain, some additional information is included in this report regarding winter jig-fishing catches in the vicinity of St. Lawrence Island during February 1983 and near Kotzbue in November 1978. Although collected outside the primary study area defined for the 1983 Chukchi investigation these data were available and serve to enhance our knowledge of Chukchi waters.

4.3 Summer Program (Land-based)

Intensive field surveys were conducted in the vicinity of Point Lay, Alaska, during summer. The sampling period was primarily divided into two increments, 17 July-4 August and 15 August-1 September. Survey efforts were most intensive during these periods, however, opportunistic samples were occasionally taken during the interim.

Figure 4-2 illustrates the sampling site locations. The programs original plan called for a fyke net to be in continuous operation at Station 1 and gill net samples to be taken at Stations 3, 4 and 5 on a rotating basis. This scheme worked well during the 15 July-4 August sampling period, however, inclement weather during the second sampling period forced us to place thefyke net on the lagoon side of the barrier island. Opportunistic gill net samples were taken at Stations 6, 7 and 8 at the discretion of the field chief.

Weather permitting, fyke and gill nets were checked daily. Fish were identified, enumerated and measured to the nearest 5 mm increment (maximum of 50 per species). Gill netted fish were retained for dietary and life history analyses. Selected species taken by fyke net were also preserved for later examination, however, stomach analyses of fyke netted fish was generally avoided since several species, most notably sculpin and cod, apparently feed on trapped fauna.

4.3.1 Water Quality

Surface water temperature, surface salinity and surface turbidity were measured in conjunction with daily fishing at each sampling station. In all cases, water temperature was measured with in-glass mercury thermometers ($\pm 0.5°C$). Salinity and turbidity were measured from water samples collected at each station. Salinity was measured using a YSI-33 salinity/conductivity meter (± 0.9 ppt above $4.0°C$, ± 1 PPt below $4.0°C$).

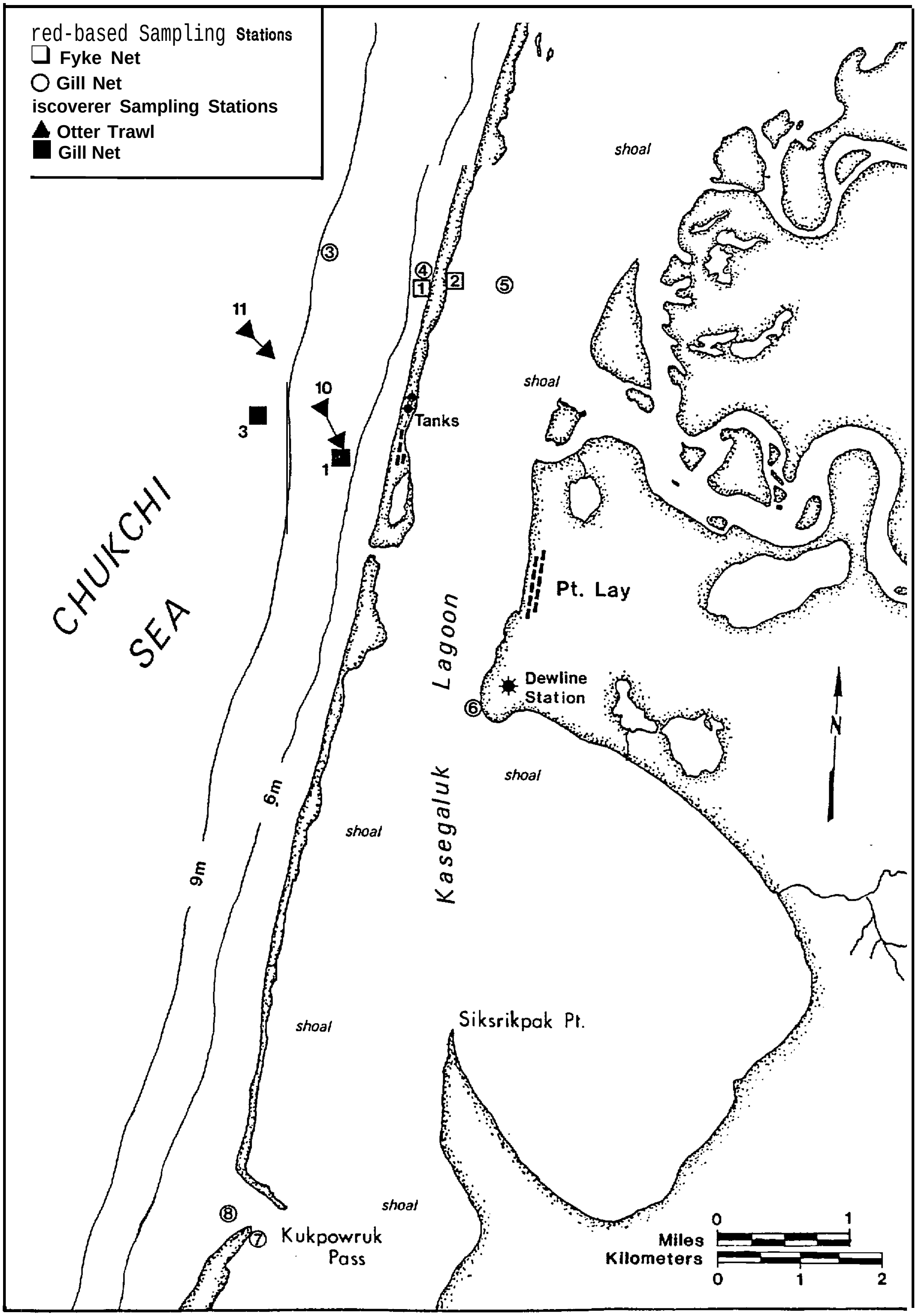


Figure 4-2. Sites sampled at Point Lay during July–August 1983. Also shown are nearshore Discoverer sampling stations.

Turbidity was measured in nephelometric turbidity units (NTU) using a Hach Model 2100 A Turbidimeter.

4.3.2 Fyke Nets

Thefyke net used at Station 1 during the 15 July-4 August sampling period actually consisted of two single trap models placed back to back (Fig. 4-3). Each single cod end trap consisted of a stainless steel frame mouth (1.2 x 1.2 m) attached to a knotless nylon net (3.7 x 0.9 x 0.9 m; 1.27 cm stretched mesh) containing two consecutive 15 x 25 cm throats. These traps were positioned on the seaward side of the barrier island at a depth of approximately 1 m. Two wings (25 cm stretched mesh) were connected to the frame--one ran diagonally to shore, the other ran diagonally seaward. Because the bottom dropped off rapidly the distal end of the seaward wing terminated at a point about 5 m offshore. This sharp drop off was the main reason for using this particular fyke net configuration.

The shallow waters of Kasegaluk Lagoon enabled us to use a conventional. 'T" configuration fyke net during the 17-31 August sampling at Station 2. A single 30 m lead was connected to the center of the main frame and twolO m leads were attached to either side. The net was set perpendicular to shore so that the trap end was in about 1.0 m of water.

4.3.3 Gill Nets

Multipaneled monofilament gill nets were employed during the Point Lay study. Surface and Bottom nets were 30 m long by 1.8 m deep and divided vertically into four equally sized panels of 2.54, 5.08, 7.62 and 10.5 mm stretched mesh.

4.4 Summer Program (Ship-based)

LGL conducted nearshore and offshore fishing efforts as part of the 24 August-15 September cruise of the NOAA research vessel Discoverer. Gill net samples were taken at 13 locations, with surface and bottom nets being simultaneously deployed at each site. Twenty-six locations were sampled by otter trawl. General sampling locations are depicted in

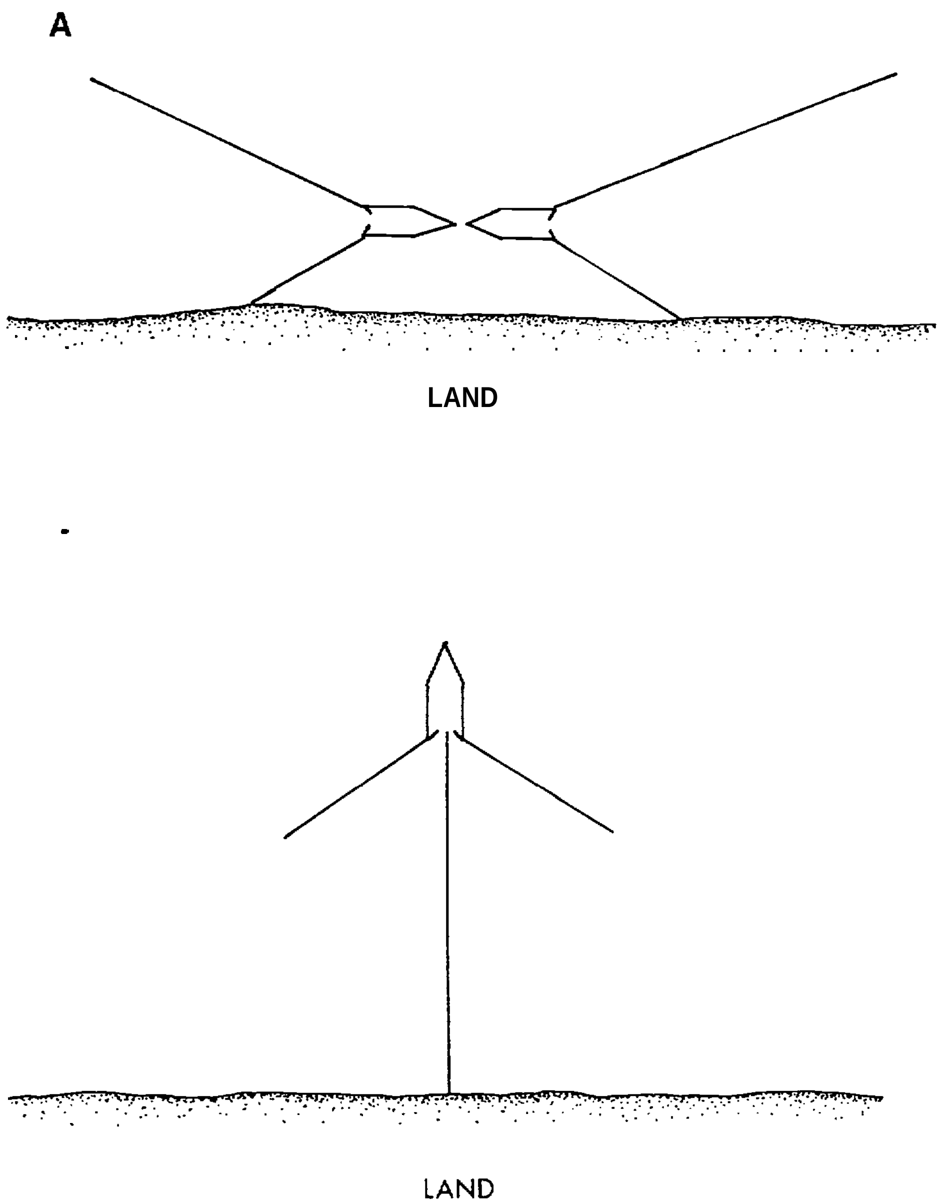


Figure 4-3. Fyke net configurations used during the 1983 Point Lay study; ocean side of barrier islands (A), lagoon side of barrier islands (B).

Figure 4-4 and the geographic coordinates of each sampling site are listed in Appendix 10-5.

The majority of tows employed a7.6 m (25′) gaP, semi-balloon otter trawl operated directly from the Discoverer. At nearshore locations (Stations 9, 10, 11,23,25, 26) too shallow (<14 m)for the Discoverer, a smaller boat was used to tow a 3.7 m (12') gap trawl. Trawl samples were weighed and fish were separated from other components of the sample. Fish were weighed and all specimens were preserved in 10% formalin. In cases where trawl samples were extremely large (Stations 1, 3, 5, 8, 12, 13, 16, 18, 21, 29), subsamples were retained.

Samples were shipped to LGL's Bryan, Texas, office for analyses. Specimens were identified, enumerated and measured (to a maximum of 100 per species). Total weight for each species was recorded for each sampling effort. Stomach contents of Arctic cod, the most consistently abundant species taken by otter trawl, were analyzed.

4.4.1 Water Quality

The Discoverer's hydrographic data acquisition system recorded vertical profiles of temperature, salinity and conductivity (CTD) at 49 locations including all deep water sampling sites (Fig. 4-5).

4.4.2 Otter Trawls

Deep water tows employed a 7.6 m (25 ft) gap, semi-balloon otter trawl with a 3.8 m stretched mesh body and a 1.3 cm stretched mesh cod end liner. All trawls were 30 min in duration with the exception of trawls 28 and 29 (15 rein). Several of the deep water trawls resulted in extremely large catches. In these instances, subsamples were retained for subsequent analyses.

Shallow water tows were made using a 3.7 m (12 ft) gap otter trawl with a 3.8 stretched mesh body and a 1.9 cm stretched mesh liner in the cod end. Nearshore trawls lasted for 9-10 min and the entire sample was preserved in each case.

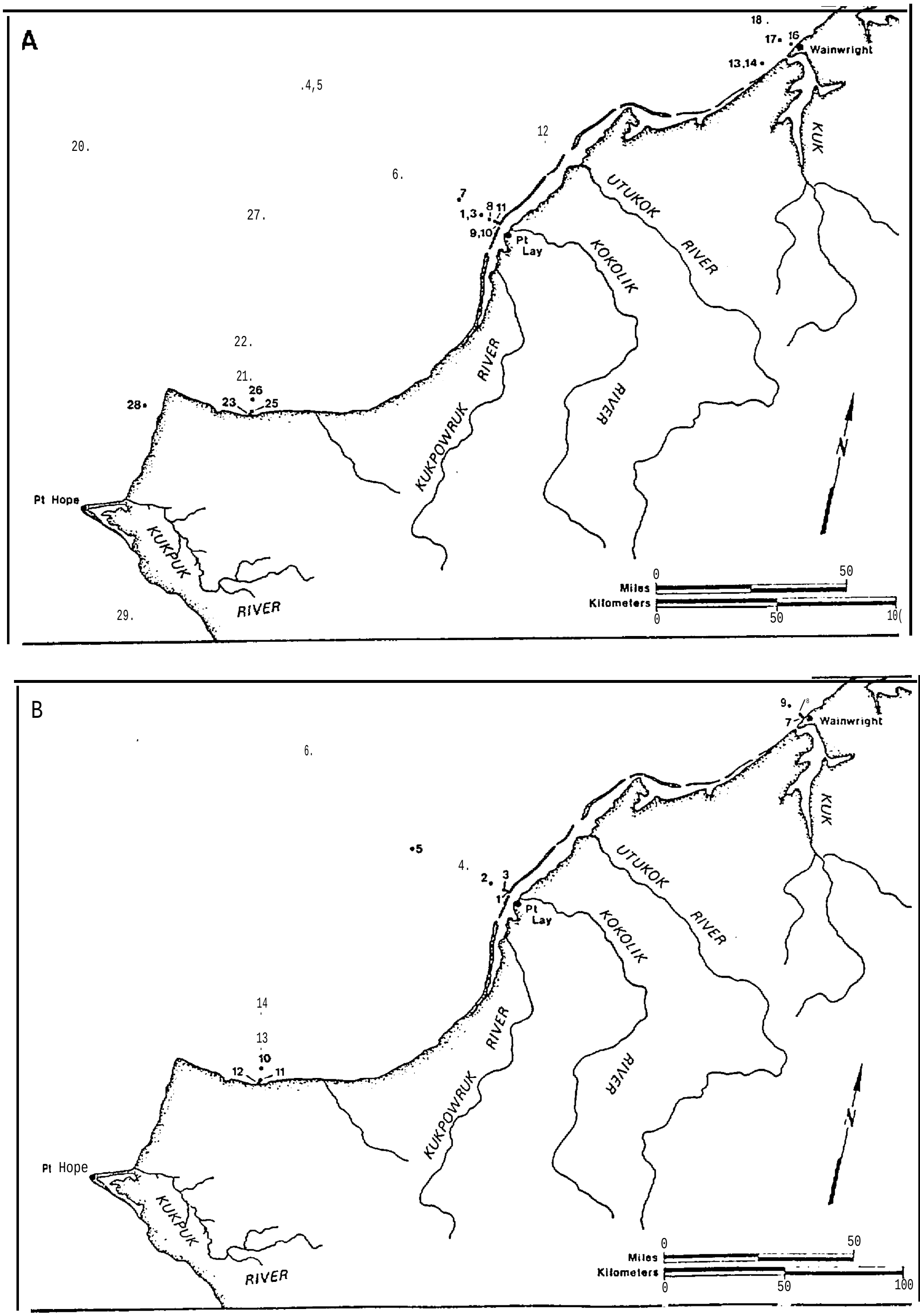


Figure 4-4. Otter trawl (A) and gill net (B) sites sampled during the 25 August-13 September 1983 Discoverer cruise.

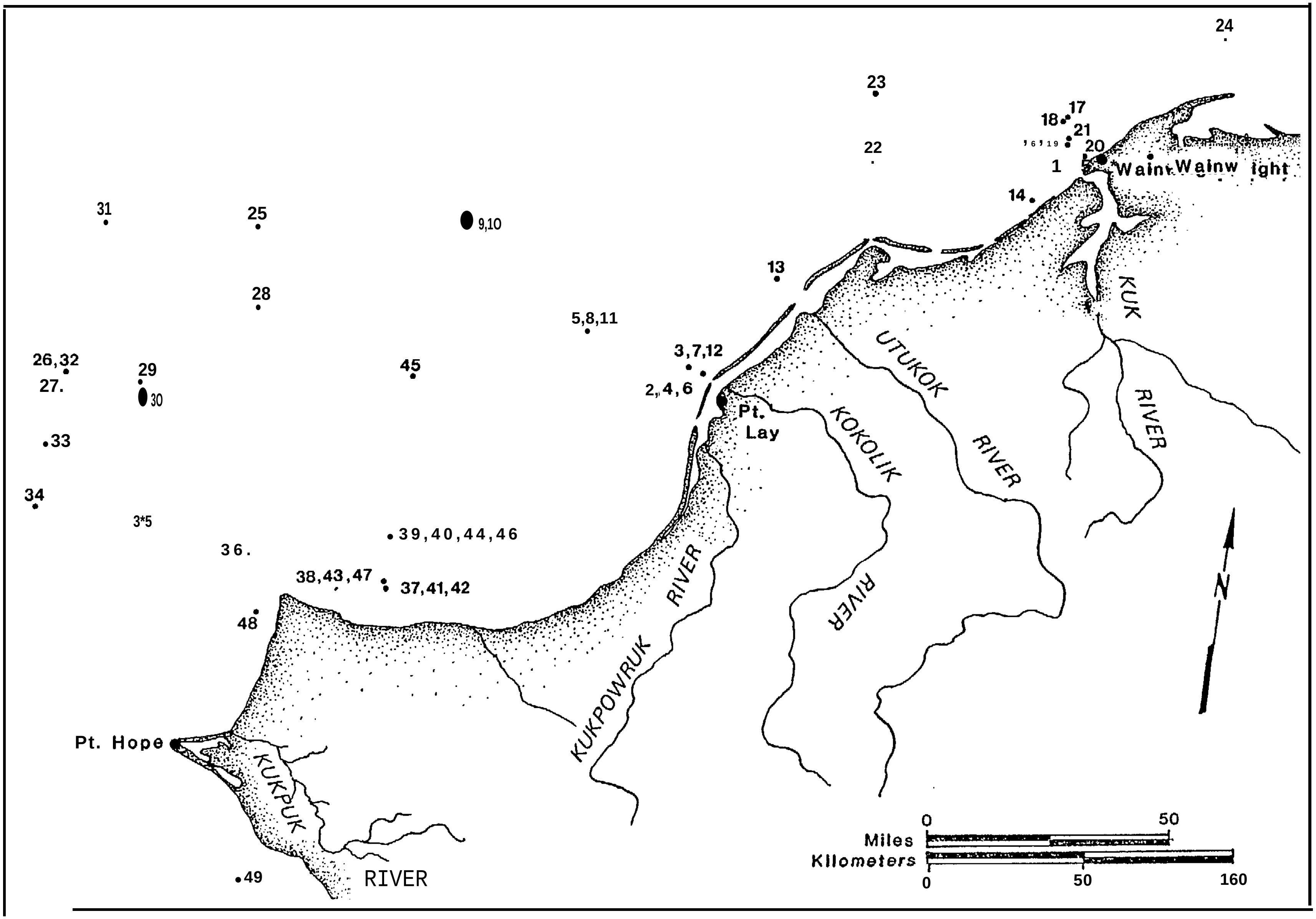


Figure 4-5. Location of CTD sampling sites during the 25 August-13 September 1983 Discoverer cruise.

4.4.3 Gill Nets

All gill nets were of monofilament construction measuring 61 m in length by 7.3 m in depth. They were vertically divided into four 15.25 m panels of 3.8, 6.4, 8.9 and 11.4 cm stretched mesh netting. All gill net efforts consisted of both surface and bottom nets. Soak time varied from 14-44 hours and all specimens were retained for preservation in 10% formalin solution.

4.5 Statistical and Analytical Procedures

4.5.1 Adjusted Catch

Otter trawl catches were adjusted to compensate for subsampling by dividing the catch (biomass) by the appropriate subsample fraction for each species at each station.

4.5.2 Catch Per Unit Effort Computations

Computation of CPUE for otter trawl samples assumes that the catch at each station is representative of abundance and diversity at that location. The computational formula for each species is given by

$$CPUE = \frac{1}{n} \sum_{i=1}^{n} N_i/A_i$$

where N_i is the number of fish caught at Station i and A_i ‘he effort at Station i. Similarly, biomass per unit effort (BPUE) was calculated by

$$BPUE = \frac{1}{n} \sum_{i=1}^{n} B_i/A_i$$

where B_i is the biomass of fish caught at Station i.

4.5.3 Analysis of Variance and Covariance

In the analysis of the winter catch of Arctic cod it was noted that differences detected across stations in measures of food availability and feeding habits (e.g., body weight and stomach content weight) may be due to differences unrelated to feeding habits. For example, differences found in body weight between stations may be due to differences in length.

Analysis of covariance is a set of techniques for the adjustment of main effects tests and multiple comparison procedures for the effect of observed concomitant variables.

The first step in the analysis of covariance is a simple analysis of variance. The model after possible transformation for linearity and normality is

$$Y_{ij} = \mu + \tau_j + \Sigma ij$$

where Y_{ij} is the i^{th} replicate from the j^{th} station" At this juncture irrespective of preceding with the analysis of covariance multiple comparison procedures (Duncan, Scheffe's) may be used.

The model for analysis of covariance is given by

$$Y_{ij} = \mu + \tau_i + \beta\ (X_{ij}-\bar{X}) + \Sigma ij$$

where Y_{ij} is as above and Xij is the concomitant variable.

Before this model can be used for testing and estimation, several assumptions need to be verified. They are

1. The regression between the response variable Y and the concomitant variable X was necessary! i.e., the slopes of Y vs X within stations is significantly different from zero.
2. The relationship between Y and X is homogeneous between stations, that is the slopes of Y vs X are not significantly different across all stations.

The tests of these assumptions are given in Hicks (1973). It should be noted irrespective of whether these assumptions hold, the standard analysis of variance is still valid, though interpretation of observed differences may no longer eliminate the possible effect of the covariates.

The final step in the analysis of covariance is the main effects test and multiple comparisons procedure on the adjusted means. The means of the response variable Y adjusted for the covariate X are

$$\text{(adjusted) } \bar{Y}_{ij} = \bar{Y}_{ij} + \hat{\beta}\ (\bar{X}_{ij}-\bar{X}_{..})\ .$$

where Y_{ij} is the mean of the Y's for the j^{th} station, X_{ij} is the mean of the X's for the j^{th} station, X.. the grand mean of the X's and the overall pooled slope of the regression of Y on X. Again, details of the main effects test and multiple comparisons procedures for the adjusted means are given in Hicks (1972).

4.5.4 Cluster Analysis

In order to compare and describe the relationships among stations or species with respect to the stomach contents of fish, cluster analyses were performed. This analysis was completed on two seperate data sets:

1. Arctic cod of similar length collected at 10 otter trawl stations, and
2. Selected species from gill net catches at Point Lay.

In both analyses the attribute (clustering variable) used was the percent of total stomach content biomass each observed content taxa constituted. In the first analysis classifications to be clustered were designated as stations. In the second, classifications were specified as fish species. Because of its demonstrated utility in ecology (Boesch 1977), a Bray-Curtis metric with complete linkage, clustering algorithm was used. The Bray-Curtis metric is a particular distance measure for determining the similarity of two classifications. The similarity, S_{jk} of classifications j and k is given by

$$S_{ij} \cdot \frac{2 \sum_{i=1}^{n} \text{'in} (X_{ij}, \text{'ik})}{\sum_{i=1}^{n} (X_{ij} + X_{ik})}$$

'here X_{ij} is the value of the clustering variable for the i^{th} stomach content taxa and j^{th} classification. Dissimilarity D_{jk}, 'Seal 'n 'he dendrograms, is given by

$$D_{jk} = 1-S_{jk} \quad .$$

Complete linkage refers to the technique of determining the similarity of two classification clusters as a function of their least similar entities (Boesch 1977).

5.0 RESULTS AND DISCUSSION

This section provides a general summary of field and analytical results for the winter, Point Lay summer, and *Discoverer* cruise sampling efforts. Inmost cases results pertaining to specific species will be discussed in the Species Accounts section. Catch and hydrographic data are tabulated in the Appendices. Appendix 10.1 contains physical data (temperature, salinity and turbidity) for the winter and Point Lay summer studies; 10.2 provides length-weight measurements for cod taken in winter; 10.3 tabulates fish catch and effort data for the Point Lay summer study; 10.4 contains length-frequency data by gear type for dominant species taken during the Point Lay summer study; 10.5 shows fish catch and effort data for the *Discoverer* cruise; and 10.6 provides length-frequency data for the dominant species caught during the *Discoverer* cruise.

5.1 Winter Study

5.1.1 Water Quality Summary

Vertical profiles of salinity and turbidity are depicted in Figure 5-1 for Stations 1 (18 March), 2 (18 March), 3 (22 March) and 4 (29 March). Depth related changes in salinity were negligible at Stations 2 and 4, however, stratification at Station 2 may not have been detected since total depth in this area exceeded 20 m. Total depth at Stations 1, 3 and 4 were 6 m, 13 m and 11 m, respectively. Bottom salinity in Peard Bay proper (Station 1) was 3 ppt greater than at the surface. Salinity decreased linearly with depth at Station 3, falling from 25.1 ppt at the surface to 16.5 ppt at a depth of 10 m. This trend at Station 3 may reflect freshwater influence from the nearby Kuk River.

Daily surface salinities remained fairly constant within stations, ranging from 28.1-33.3 ppt at Station 2 (18-22 March), 25.1-28.0 at Station 3 (20-23 March), and 29.7-31.0 ppt at Station 4 (24-28 March).

Surface temperature remained between -0.5 and -1.0°C regardless of location or date. Turbidity values were low, ranging from 0.5-5.5 NTU (Fig. 5-1).

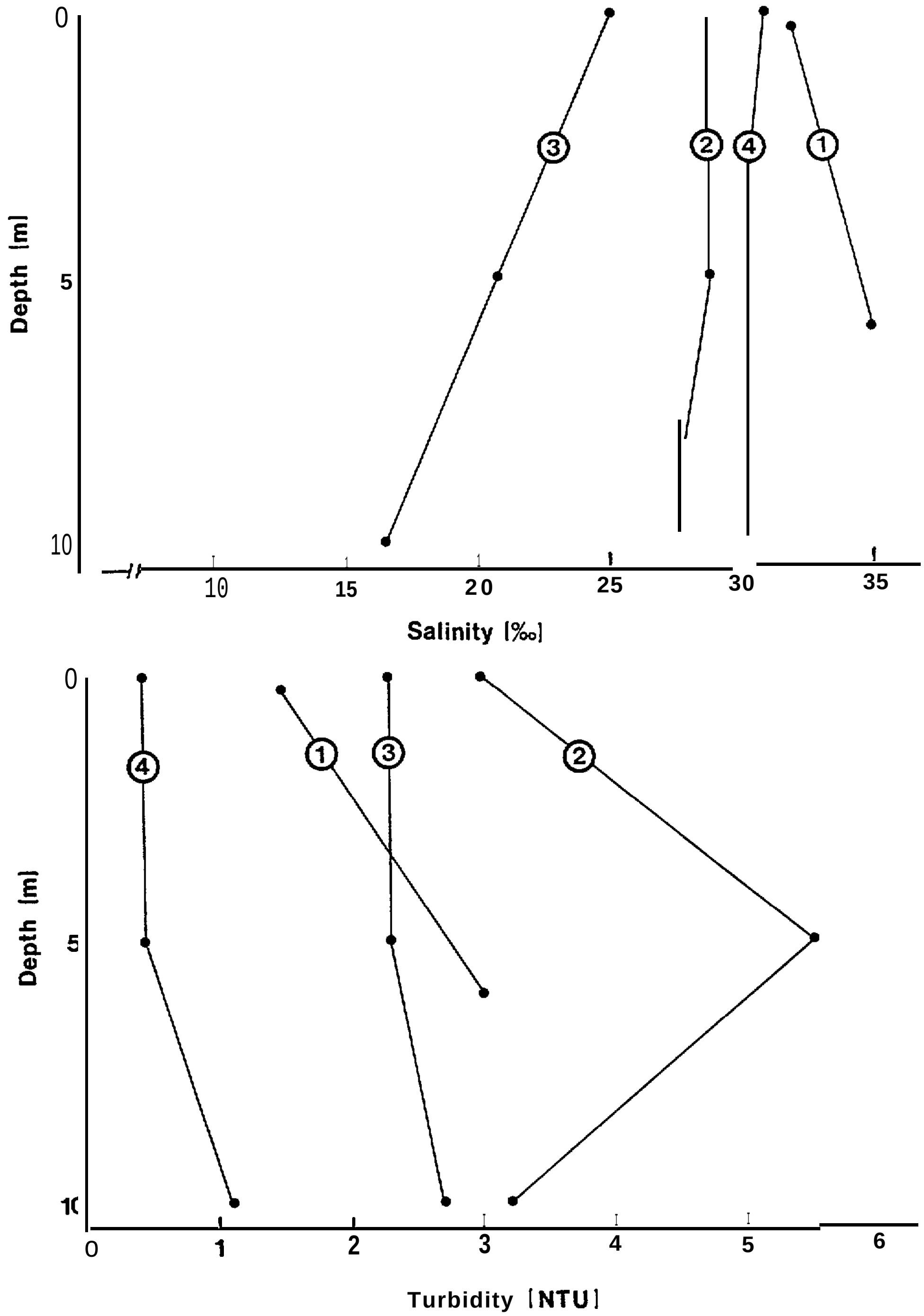


Figure 5-1. Vertical profiles of salinity and turbidity recorded at Stations 1 (Peard Bay proper), 2 (Peard Bay), 3 (Wainwright) and 4 (Ledyard Bay) during 15-28 March 1983.

5.1.2 Catch Summary and Total Abundance

Winter fyke-netting resulted in the capture of 205 fish--204 Arctic cod (Boregadus saida) and 1 sculpin (Table 5-l). The lone sculpin was taken at Station 3 on 22 March.

Table 5-1. Catch summary for Arctic cod taken by fyke net during 16-28 March, 1983.

	Station			
Date	1	2	3	4
3/16/83	2			
3/18/83		18		
3/19/83		40		
3/20/83		28		
3/21/83		58	20	
3/22/83		15	4	
3/23/83			3	
3/15/83				5
3/26/83				2
3/27/83				2
3/28/83				7

Gill nets failed to capture any fish during the entire winter sampling period even though efforts encompassed over 270 total hours of soak time: five days at Station 2, three days at Station 3, and four days at Station 4. The disparity in Arctic cod catch between gill and fyke nets, given that both were set in close proximity to and at the same depth and time of each other, illustrates gear selectivity. Arctic cod taken by fyke net ranged from 44-99 mm FL and thus may have been too small for the 2.5, 3.8 and 5.1 cm gill net mesh sizes. Fyke net leads were not only constructed of smaller mesh net (1.3 cm) but also acted in a different capacity--directing fish movement as opposed to entangling fish. A similar occurrence of gear selectivity was reported by Griffiths et al. (1983). During periods in which their fyke nets were capturing thousands of Arctic cod, nearby gill nets took only a token number. Further, their tri-paneled gill nets (minimum mesh size = 1" stretched mesh) failed to capture cod less than 100 mm FL. Craig and Haldorson (1981) also reported that gill nets were inefficient in capturing small Arctic cod in Simpson Lagoon.

5.1.3 Kotzebue and St. Lawrence Island

First reported by Craig and Haldorson (1981) the 33 saffron cod (*Eleginus gracilis*) collected were part of a subsistence catch of "tomcod" jigged through the ice just offshore from the village of Kotzebue, Southeast Chukchi Sea, on 15-30 November 1978.

During February 1983, saffron cod were jigged through the ice at a location about 1.5 km east of Savoonga, St. Lawrence Island. Arctic cod were jigged at the mouth of Fossil River, about 1.5 km southeast of Camp Iveetok.

All collected specimens were analyzed for length, weight, reproductive status, age and stomach content, and results are reported in the Species Account Section.

5.2 Point Lay Study

5.2.1 Water Quality Summary

Temperature, salinity and turbidity data are presented in Figure 5-2 for Stations 1 and 2. Data collected at these sites offer the best temporal profile of local hydrographic conditions because they were the stations most consistently monitored during the sampling period.

Two main warming trends in ocean water occurred during the first half of the sampling program--elevated temperatures were recorded from 20-23 July and from I-6 August. A similar but reciprocal trend was noted in salinity. The 20-23 July period was characterized by mild SE winds and warm air temperatures. Warm freshwater discharge from the Kokolik and Kukpowruk rivers would account for observed temperature and salinity levels. River influence is evident in the generally lower salinity of lagoon water as compared with ocean water. Strong N-NW winds and heavy seas prevailed before and after the 20-23 July period. The resultant wind-driven influx of cold marine water served to lower the temperature and increase the salinity of coastal ocean water. Both lagoon and ocean water levels were higher at this time.

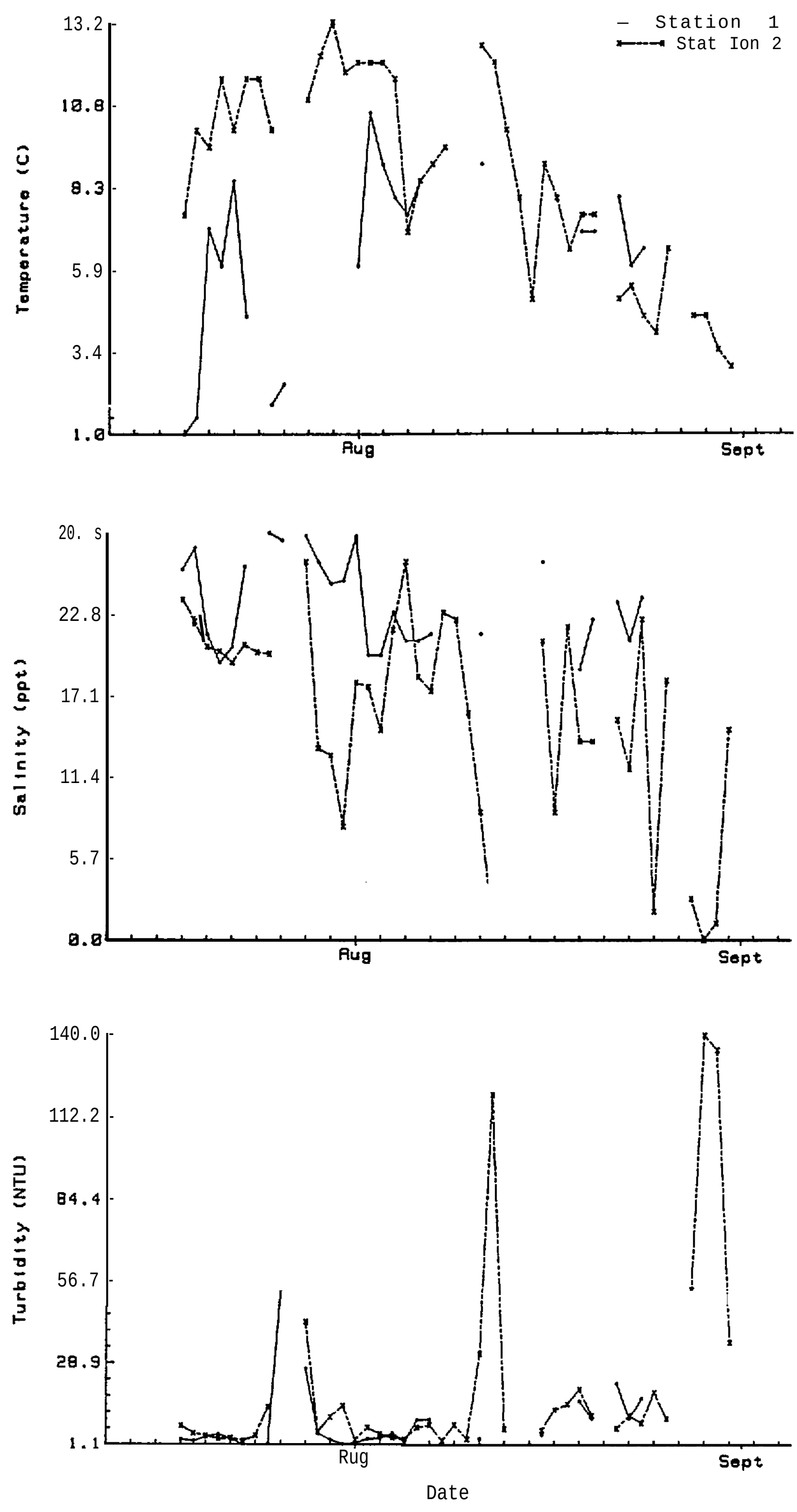


Figure 5-2. Temperature, salinity and turbidity recorded at Point Lay fyke net Stations 1 and 2 during July-August 1983.

The lack of consistent hydrographic data for the ocean station during the second half of the summer sampling period makes comparative analysis difficult. Lagoon waters generally underwent a steady decrease in temperature during the last two weeks in August. This decline may be attributable, in part. to decreased river discharge and colder air temperatures. Sharp drops in lagoon salinity and spikes in turbidity around 12 and 29 August were accompanied by offshore and NE winds which tended to churn and lower the level of lagoon waters.

5.2.2 Catch Summary and Total Abundance

Fyke and gill netting efforts resulted in the capture of 17 fish species totaling 14,437 individuals--13,345 by fyke net and 1092 by gill net (Table 5-2). Marine species (10) accounted for nearly 99% of the total fyke net catch with the dominant species being Arctic cod (39%), capelin (25%), fourhorn sculpin (20%) and Arctic flounder (13%). The most abundant species taken by gill net were Pacific herring (48%), fourhorn sculpin (18%), boreal smelt (17%) and Arctic flounder (9%).

These data illustrate the size/species selectivity of the different gear types. Nearly half of the 1092 gill-netted fish were Pacific herring, yet not a single herring was taken by either fyke net. Conversely, fyke nets captured 5205 Arctic cod while gill nets took only 12. Boreal smelt were taken by both gear types; however, while gill nets caught fish predominantly in the 200-260 mm length range, better than 60% of those caught by fyke net were less than 130 mm in length.

When compared with nearshore summer surveys conducted in the Beaufort Sea region, the most prominent feature of the 1983 Point Lay catch is the virtual absence of anadromous fish (Table 5-3). As in the Present study, Beaufort Sea fyke net catches were generally dominated by Arctic cod and fourhorn sculpin. Excluding these two species, Arctic cisco, least cisco, Arctic char and broad whitefish accounted for -73% of the remaining catch at Simpson Lagoon in 1978 and more than 90% of remaining catches at Simpson Lagoon (1977), Prudhoe Bay (1981) and the Sagavanirktok River delta (1982). During the latter three studies, Arctic cisco alone constituted 14.7, 15.0 and 29.1% of total fyke net catche, respectively.

Table 5-2. Point Lay catch summary for July-August. 1983.

Species	Station: Ocean Fyke	Lagoon Fyke	Ocean Gill	Lagoon Gill	Total
Arctic cod (*Boreogadus saida*)	4014	1191	12	0	5217
Capelin (*Mallotus villosus*)	3343	1	16	0	3360
Fourhorn sculpin (*Myoxocephalus quadricornis*)	1491	1152	146	56	2845
Arctic flounder (*Liopsetta glacialis*)	1512	202	25	71	1810
Pacific herring (*Clupea harengus pallasi*)			457	70	527
Boreal smelt (*Osmerus mordax*)	1	133	144	42	320
Saffron cod (*Eleginus gracilis*)	110	155	3	1	269
Pink salmon (*Oncorhynchus gorbuscha*)	5	1	28	0	34
Great sculpin (*Myoxocephalus polyacanthocephalus*)	24	1	4	1	30
Longhead dab (*Limanda proboscidea*)	1		10	1	12
Arctic char (*Salvelinus alpinus*)	2	1			3
Sturgeon poacher (*Agonus acipenserinus*)			3	0	3
Least cisco (*Coregonus sardinella*)	2				2
Bering cisco (*Coregonus laurettae*)		1	1		2
Pacific sand lance (*Ammodytes hexapterus*)		1			1
Chum salmon (*Oncorhynchus keta*)				1	1
Threespine sticklebacks (*Gasterosteas aculeatus*)		1			1
	10,505	2840	659	433	14,437

Table 5-3. Fyke net catch summary for the six most abundant fish species caught during nearshore summer surveys in the Beaufort Sea. Values are percent of total catch followed parenthetically by catch per fyke net day.

	Beaufort Sea: Simpson Lagoon[1] 1977	Simpson Lagoon[1] 1978	Prudhoe Bay[2] 1981	Sagavanirktok Delta[3] 1982	Chukchi Sea: Point Lay 1983
Arctic cod	7.6 (6.5)	77.9 (1607.1)	49.2 (179.8)	27.9 (147.7)	39.0 (183.1)
Fourhorn sculpin	69.6 (59.1)	17.9 (369.3)	23.7 (86.4)	?7.7 (146.9)	19.8 (93.0)
Arctic cisco	14.7 (12.5)	0.8 (16.5)	15.0 (54.7)	29.1 (154.4)	0 (0)
Least cisco	2.3 (1.9)	1.2 (24a)	6.6 (24.0)	2.3 (12.5)	<0.01 (0.07
Arctic char	3.8 (3.2)	0.9 (18.6)	2.3 (8.5)	5.1 (27.8)	<0.01 (0.1
Broad whitefish	0.1 (0.8)	0.2 (3.1)	0.9 (3.1)	5.6 (29.7)	0 (0)
Others	1.9	1.1	2.3	2.3	41.2

[1]Craig and Haldorson 1981.
[2]Griffiths and Gallaway 1982.
[3]Griffiths et al. 1983.

The 28 fyke net days at Point Lay resulted in the capture of three Arctic char and two least cisco. Not a single Arctic cisco or broad whitefish were taken, however, one Arctic cisco was caught at Point Lay during summer 1983 (Schmidt and Craig, in press). None of these species were taken by gill net and together the four species comprised 0.04% of the 1983 Point Lay catch.

5.2.3 Catch Rate

There is a noticeable similarity between hydrographic trends and overall fyke net catch (Fig. 5-3). Catch per unit effort (CPUE) for all fish increased during sharp transitions in temperature and salinity. This similarity may reflect the effect of sea conditions upon localized fish distribution. Northerly winds responsible for lower temperatures also created extremely rough seas and surf. The site of fyke net Station 1 in the barrier island surf zone would most likely be avoided by fish during harsh weather. Deeper, offshore waters, or Kasegaluk Lagoon, could serve as havens against these rough surface conditions. Conversely, repopulation of the surf corridor during calmer periods (elevated temperatures) could account for the observed increases in catch.

5.2.4 Trophic Comparisons

The stomachs of 141 fish collected at Pt. Lay were examined for content. Five species were represented and with the exception of capelin, all specimens were taken by gill net. Detailed lists of stomach contents are provided in the Species Accounts Section.

Figure 5-4 denotes the presence of particular food items for each species. Cluster analysis revealed several similarities in feeding strategy among species (Fig. 5-5). Pink salmon and boreal smelt both tended to be piciverous, with fish accounting for 75 and 65% (of total wet weight content) of their diets, respectively (Tables 6-8 and 6-5). Fish and Mysis littoralis together comprised 80% (pink salmon) and 95% (boreal smelt).

The diets of capelin (95%) and Pacific herring (78%) were dominated by Mysis littoralis (Table 6-4). Fourhorn sculpin taken from both the ocean and lagoon sides of the barrier island fed predominantly on the

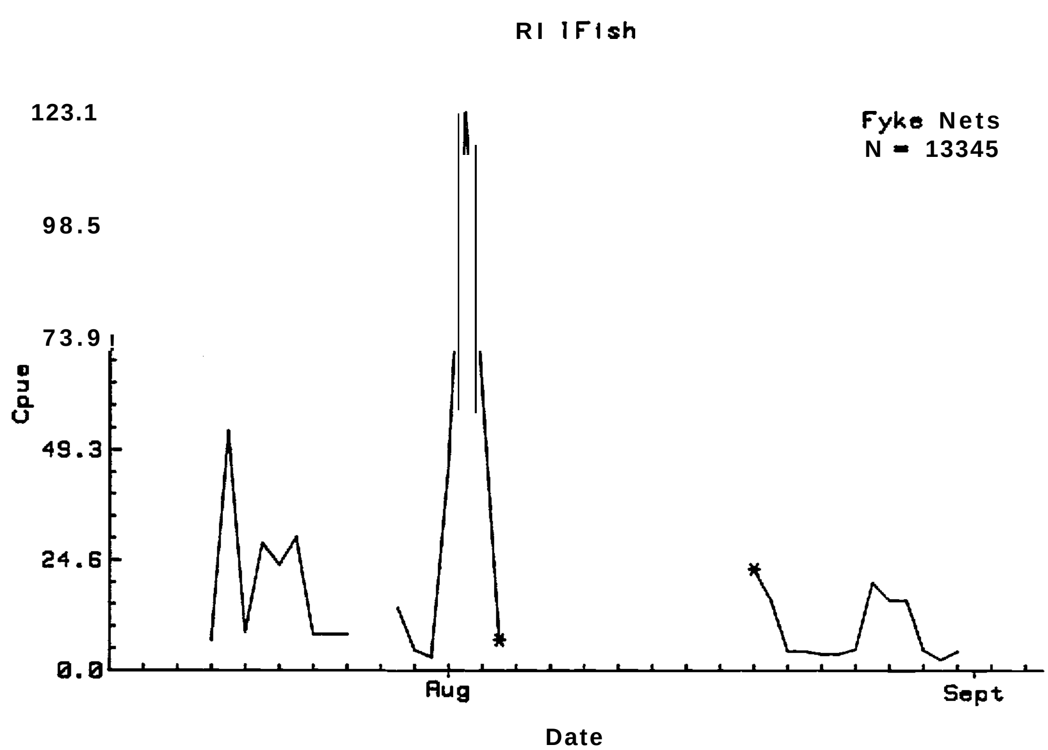


Figure **5-3.** Daily catch rate (fish/h) of all fish taken by Point Lay fyke nets during July-August **1983.**

COINCIDENCE TABLE

SPECIES

STOMACH CONTENTS	Capelin	Pacific Herring	Pink Salmon	Boreal Smelt	Arctic Flounder	Fourhorn Sculpin Ocean	Fourhorn Sculpin Lagoon
Ephemoptera nymph							X
Calanoid	X	X		X	X		
Calanus glacialis		X					
Temora sp.							
Cyclopoid							
Harpacticoid	X	X					
Euphausiid	X		X				
Atylus carinatus			X				
Parathemisto abyssorum			X				
Amphipod	X	X	X	X	X	X	X
Onisimus littorals		X	X	X		X	
Onisimus glacialis				X			X
Lysianassid	X			X	X	X	X
Gammarus setosus			X	X	X	X	X
Pontoporeia affinis		X		X	X		X
Oedicerotid	X	X	X	X	X		
Anonyx sp.			X				
Gammaracanthus			X				
Polychaete		X			X	X	
Unidentified worm					X		
Cirripede larvae							X
Bivalve							X
Saduria entomon		X		X	X	X	X
Mysid	X	X	X				
Mysid littorals	X	X	X	X	X	X	X
Mysid relicts		X	X	X			X
Neomysis sp.	X	X	X	X			
Cumacea	X	X					
Fish egg			X				
Unidentified fish				X		X	X
Fish larvae	X	X	X	X			
Arctic cod		X	X	X		X	X
Fourhorn sculpin		X					X
Saffron cod						X	
Flatfish			X				
Ninespine sticklebacks							
Sand lance		X					
Decapod shrimp						X	
Juvenile decapod			X				

Figure 5-4. Food items consumed by fish taken at Point Lay during July-August 1983.

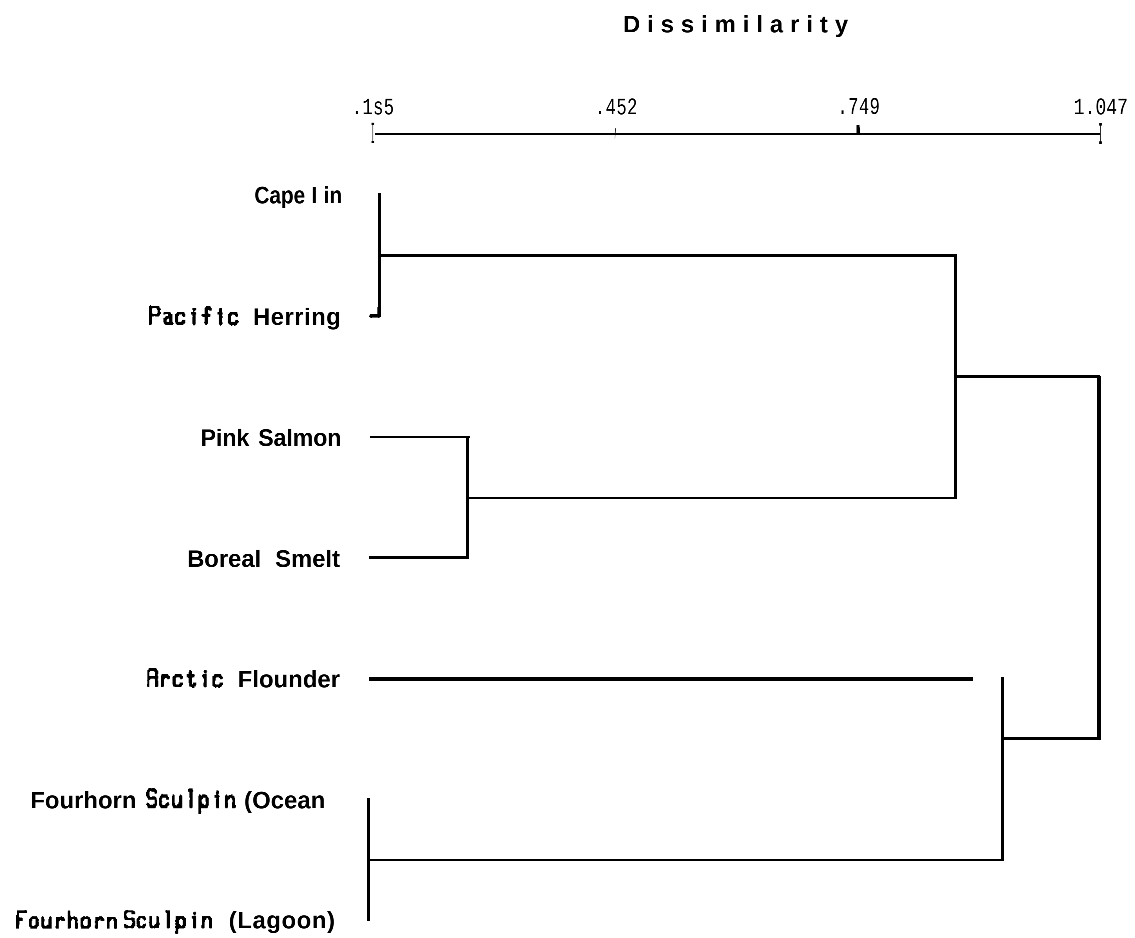


Figure 5-5. Cluster analysis dendrogram for six species of fish based on stomach content of specimens taken at Point Lay during July-August 1983.

isopod Saduria entomen: lagoon 65%, ocean 81% (Table 6-3). The benthic nature of Arctic flounder is reflected in the high incidence (48%) of tubular polychaetes (Table 6-7). A large remaining portion of their diet was unidentified worms (35%).

Because invertebrate sampling was not included in this study the ecological significance of these dietary dissimilarities/similarities in terms of competition is unclear. Even if these data were available, it is likely that different food preferences would be correlated with the functional design and feeding strategy of individual species. Any hypothesis regarding the trophic stability of the Kasegaluk Lagoon system would require a more detailed investigation of food availability and its relation to dietary overlap.

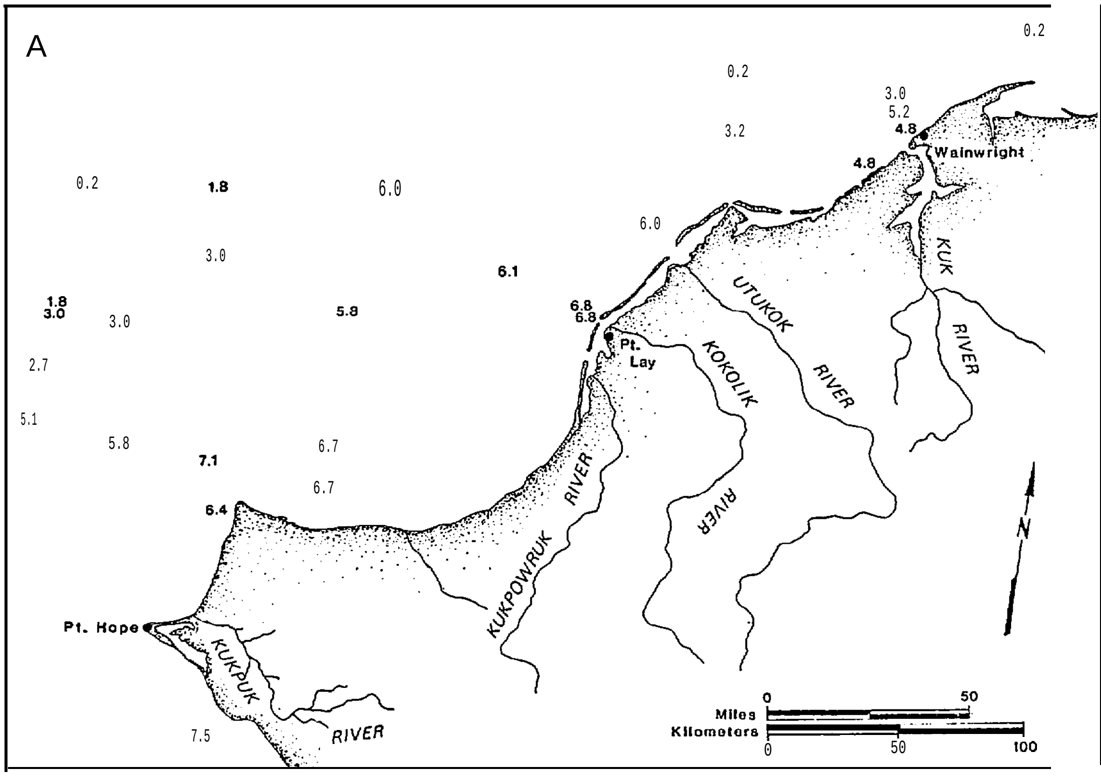
5.3 Discoverer Cruise

5.3.1 Water Quality Summary

Ocean temperatures ranged from -0.8 to 7.5°C (Fig. 5-6). Warmest waters (~≥6°C) occurred southeast of Icy Cape, extending from the coast to as far as 150 km offshore for surface water and 75 km offshore for bottom water. This thermal plume reflects the N-NE flow of warm water from the Bering Sea. Decreasing bottom temperatures coincided with increased distances from shore and greater depth. The interface between the Bering Sea plume and colder Arctic Ocean water was evidentin a sharp decrease (~3°C) in sea surface temperature approximately 150 km offshore. Northeast of Icy Cape, where Chukchi and Beaufort Seawater masses mix, nearshore temperatures were somewhat cooler (~3-5°C).

Salinity was relatively constant throughout the study area, with surface and bottom conditions ranging from 28-32 ppt (Fig. 5-7). Lowest salinities were observed in nearshore areas near the mouths of major river drainages.

Vertical profiles of temperature and salinity were homogeneous at most of the nearshore stations (2, 4, 6, 12-16, 19-22, 36-47) where depths were less than 25 m. Deep water stations (>25 m) were characterized by distinct thermoclines and haloclines of varying duration and depth. Subsurface extensions of the warm Bering Sea plume into the colder Arctic



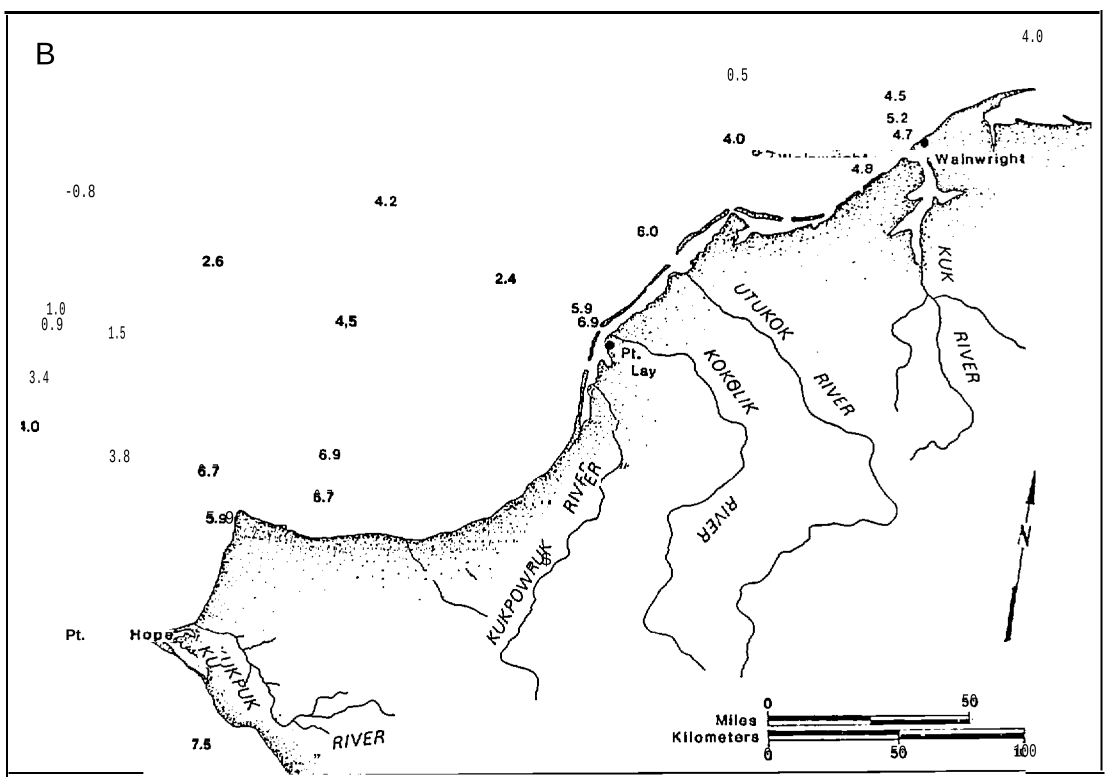


Figure 5-6. Surface (A) and bottom (B) temperatures recorded during the **25** August-13 September 1983 Discoverer cruise.

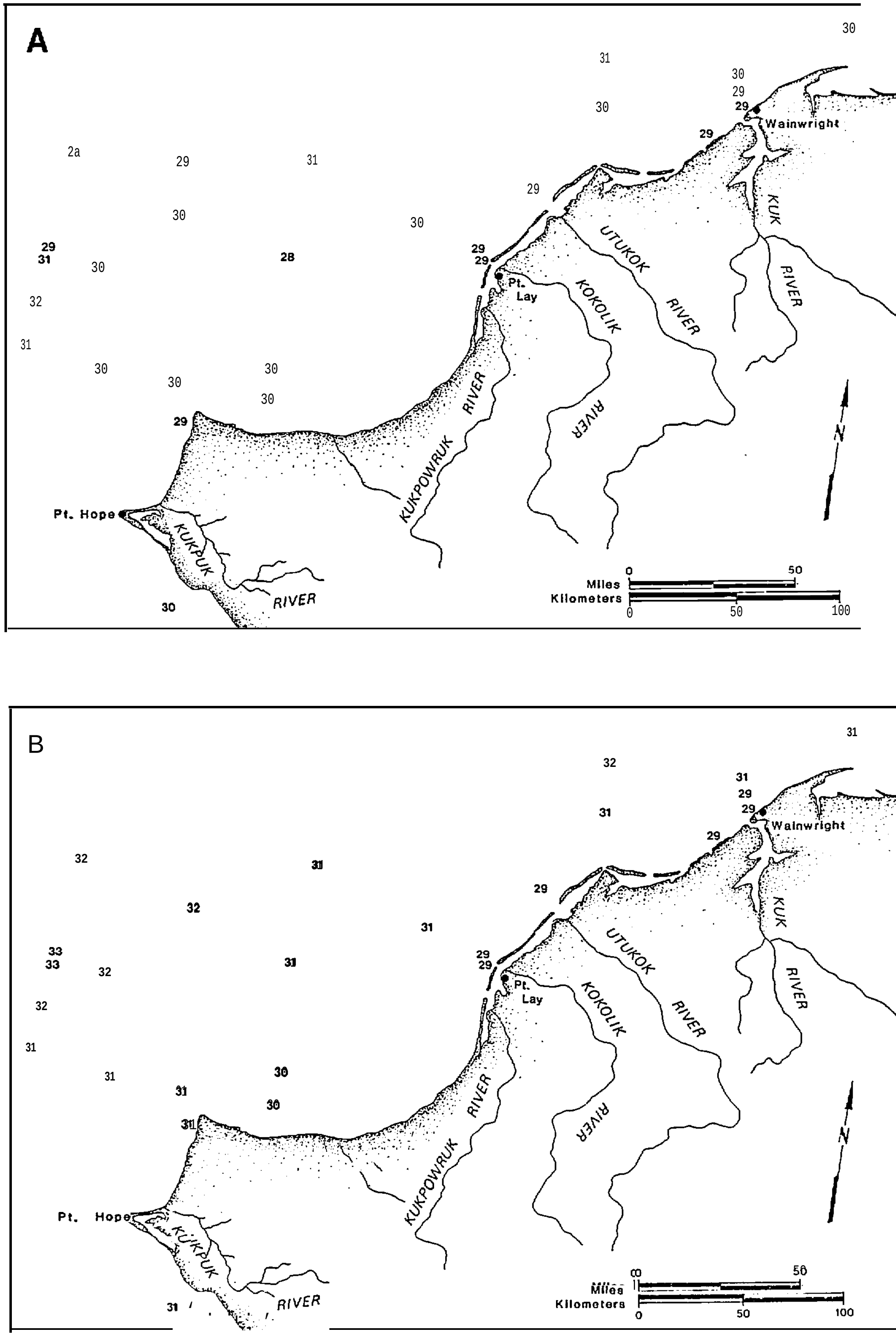


Figure 5-7. Surface (A) and bottom (B) salinities recorded during the 25 August-13 September 1983 Discoverer cruise.

Ocean water mass were observed at Stations 23, 25, 26, 28, 29 and 32 (Fig. 5-8) .

5.3.2 Catch Summary and Total Abundance

Otter trawl and gill-netting efforts caught a total of 7849 fish representing 5 orders, 12 families and 31 species (Table 5-4). Adjusted otter trawl catch at deep water stations (>14 m, 25 ft trawl) was dominated by Arctic staghorn sculpin (52%), Arctic cod (21%), shorthorn sculpin (8%), hamecon (7%) and saffron cod (5%) (Table 5-5). Together, these five species accounted for 93% of adjusted catch biomass: Arctic cod, 54%; Arctic staghorn sculpin, 24%; shorthorn sculpin, 7%; saffron cod, 6% and hamecon, 2%. In terms of percent average CPUE and percent average biomass per unit effort (BPUE) there is a change in the proportions of the two dominant species. Arctic staghorn sculpin increased from 52% to 55% of catch and from 24% to 29% of biomass while Arctic cod decreased from 21% to 17% of catch and 54% to 42% of biomass. This shift occurs because trawls focus was made in areas where Arctic cod were more abundant.

Comparisons of adjusted catch for nearshore stations (<14 m depth, 12 ft trawl) showed Arctic staghorn sculpin to be numerically dominant (51%) followed by shorthorn sculpin (19%), hamecon (14%), saffron cod (6%) and Arctic cod (3%) (Table 5-6). These five species comparised 96% of total biomass with 62% attributable to Arctic staghorn sculpin alone. Only a slight shift was noted in catch composition when viewed in terms of percent average CPUE and percent average BPUE.

Nine species totalling 102 fish were taken by gill nets of which Pacific herring and boreal smelt accounted for 46 and 33 specimens, respectively.

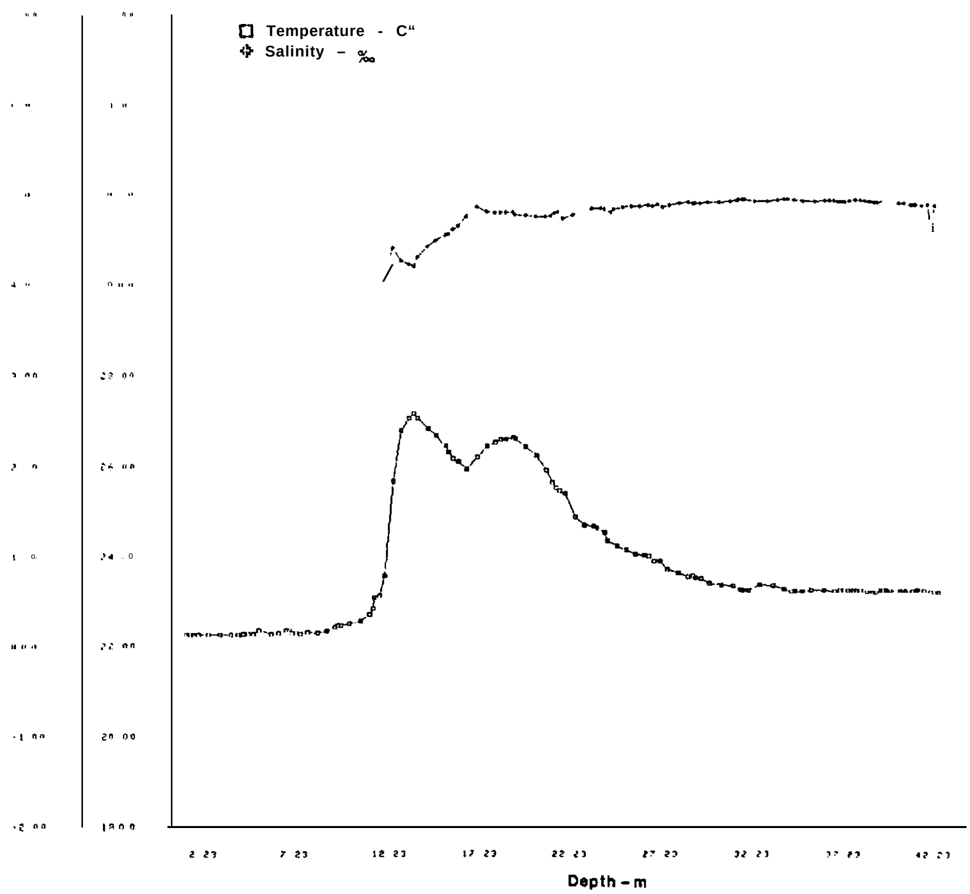


Figure 5-8. Vertical profile of temperature and salinity recorded at CTD Station 23. The subsurface band of warm water was indicative of Stations 23, 25, 26,]8, 29 and 32.

Table 5-4. Species caught during the 1983 *Discoverer* cruise.

CLUPEIFORMES

- **Clupeidae**
  - Pacific herring - *Clupea harangus pallasi*

SALMONIFORMES

- **Salmonidae**
  - Arctic char - *Salvelinus alpinus*
- **Osmeridae**
  - Boreal smelt - *Osmerus mordax*

GADIFORMES

- **Gadidae**
  - Arctic cod - *Boreogadus saida*
  - Saffron cod - *Eleginus gracilis*
  - Walleye pollock - *Theragra chalcogeamma*
- **Zoarcidae**
  - Fish doctor - *Gymnelis viridis*
    - *Gymnelis hemifascratus*
  - Polar eelpout - *Lycodes polaris*
  - Arctic eelpout - *L. reticulatus*
  - Archer eelpout - *L. sagittarius*
  - Saddled eelpout - *L. muscosus*

PERCIFORMES

- **Stichaeidae**
  - Fourline snakeblenny - *Eumesogrammus praecisus*
  - Slender eelblenny - *Lumpenus fabricii*
  - Arctic shanny - *Stichaeus punctatus*
- **Ammodytidae**
  - Sandlance - *Ammodytes hexapterus*
- **Hexogrammidae**
  - Whitespotted greenling - *Hexogrammos stelleri*
- **Cottidae**
  - Hamecon - *Artediellus scaber*
  - Spatulate sculpin - *Icelus spatula*
  - Antlered sculpin - *Enophrys diceraus*
  - Arctic staghorn sculpin - *Gymnocanthus tricuspis*
  - Fourhorn sculpin - *Myoxocephalus quadricornis*
  - Shorthorn sculpin - *M. scorpius*
  - Eyeshade sculpin - *Nautichthys pribilovius*
  - Ribbed sculpin - *Triglops pingeli*
- **Agonidae**
  - Sturgeon seapoacher - *Agonus acipenserinus*
  - Arctic alligatorfish - *Asidophoroides olriki*
- **Cyclopteridae**
  - Snailfish - *Liparis* spp.

PLEURINECTIFORMES

- **Pleuronectidae**
  - Alaska plaice - *Pleuronectes quadrituberculatus*
  - Arctic flounder - *Liopsetta glacialis*
  - Yellowfin sole - *Limanda aspera*
  - Longhead dab - *Limanda proboscidea*

Table 5-5 Catch summary for deep water (>14m) stations sampled by 25' otter trawl during the 1983 Discoverer cruise.

Species	Ad Justed Catch	AdJusted Biomass	Average CPUE	Average BPUE	Percent Average CPUE	Percent Average BPUE
Arctic staghorn sculpin	10699	186873	250.976	4447.25	55	29
Arctic cod	4339	424547	76.634	6421.20	17	42
Shorthorn sculpin	1608	51388	39.100	1386.28	9	9
Hamecon	1372	17698	33.169	470.64	7	3
Saffron cod	1054	50587	19.834	1375.90	4	9
Slender eelblenny	570	12353	8.724	193.78	2	1
Ribbed sculpin	366	6986	7.067	146.92	2	•
Sand lance	106	1584	2.253	35.46	•	•
Snailfish	101	1734	2.184	42.26	•	•
Sturgeon seapoacher	88	451	1.943	9.50	•	•
Antlered sculpin	80	11600	2.718	394.14	•	3
Walleye pollock	68	9349	2.194	308.16	•	2
Yellowfin sole	66	929	1.275	15.76	•	•
Arctic shanny	64	954	2.050	31.74	•	•
Fish doctor	37	298	.988	8.24	•	•
Saddled eelpout	33	1104	.762	30.74	•	•
Arctic alligatorfish	28	156	.747	4.86	•	•
Eyeshade sculpin	8	18	.140	.29	•	•
Arctic eelpout	8	546	.226	13.47	•	•
Whitespotted greenling	5	72	.152	2.38	•	•
Spatulate sculpin	4	4	.078	.08	•	•
Fourline snakeblenny	4	70	.140	2.45	•	•
Pacific herring	4	1410	.123	43.40	•	•
Gymnelis hemifasciatus	3	33	.041	.45	•	•
Polar eelpout	3	78	.024	.63	•	•
Archer eelpout	1	3	.008	.02	•	•
Arctic flounder	1	32	.008	.26	•	•
Boreal smelt	1	111	.016	1.80	•	•

● < 1%

Table 5-6. Catch summary for shallow water (< 14m) stations sampled by 12' otter trawl during the 1983 Discoverer cruise.

Species	Adjusted Catch	AdJusted Biomass	Average CPUE	Average BPUE	Percent Average CPUE	Percent Average BPUE
Arctic staghorn sculpin	307	9647	98.151	4137.83	55	70
Shorthorn sculpin	115	2338	29.328	563.90	16	10
Hamecon	85	1512	17.554	258.43	10	4
Saffron cod	36	557	7.120	118.79	4	2
Arctic cod	19	734	9.667	319.35	5	5
Snailfish	15	573	9.442	412.81	5	7
Yellowfin sole	8	88	1.997	15.28	1	•
Fourhorn sculpin	4	42	3.333	35.00	2	•
Ribbed sculpin	4	42	.946	11.06	•	•
Slender eelblenny	3	47	.349	5.33	•	•
Sturgeon seapoacher	2	10	.548	2.74	•	•
Arctic alligatorfish	1	1	.123	.12	•	•

● <1%

6.0 SPECIES ACCOUNTS

This section discusses the results for individual species. While emphasis is placed on the more abundant species taken during the 1983 Chukchi study, brief summaries of data collected for less abundant species are also provided.

6.1 Arctic Cod (*Boreogadus saida*)

The Arctic cod has a circumpolar distribution extending south to the northern Bering Sea (Pereyra et al. 1977, Lowry and Frost 1981). Arctic cod are reported to be one of the most common and abundant species in Arctic waters (Alverson and Wilimovsky 1966, Quast 1974, Lowry and Frost 1981) andare known to enter nearshore areas in the Beaufort Sea (Craig and Halderson 1981, Griffiths and Gallaway 1982, Griffiths et al. 1983).

Arctic cod was one of the most omnipresent and abundant species caught throughout the course of the 1983 Chukchi investigation" With the exception of a single cottid, they were the only species taken during the winter program, the most abundant species collected at Pt. Lay during summer, and the second most abundant species collected by otter trawling from the *Discoverer.* They constituted 36% of total catch at point Lay and 21% of adjusted otter trawl catch (all stations combined).

Fyke net catch rate of Arctic cod was highly variable at Pt. Lay with spikes in CPUE coinciding with sharp changes in local hydrography: the 19 July surge preceded a 5.5°C rise in temperature and a 6 ppt decrease in salinity recorded on 20 July; a 4.5°C rise in temperature and a 8 ppt drop in salinity accompanied the 2 August pulse in CPUE and a 22 ppt decrease in salinity occurred simultaneously with the 25 August surge (Fig. 6-1). Griffiths et al. (1983) reported similar pulses of Arctic cod near the Sagavanirktok River delta, however, they were always associated with salinity increases. The nearshore abundance of Arctic cod is apparently linked with hydrographic characteristics and/or movements in water mass.

6.1.1 Size

Arctic cod taken during the winter survey ranged in size from 45-100 mm fork length (FL) with a cumulative length-frequency distribution

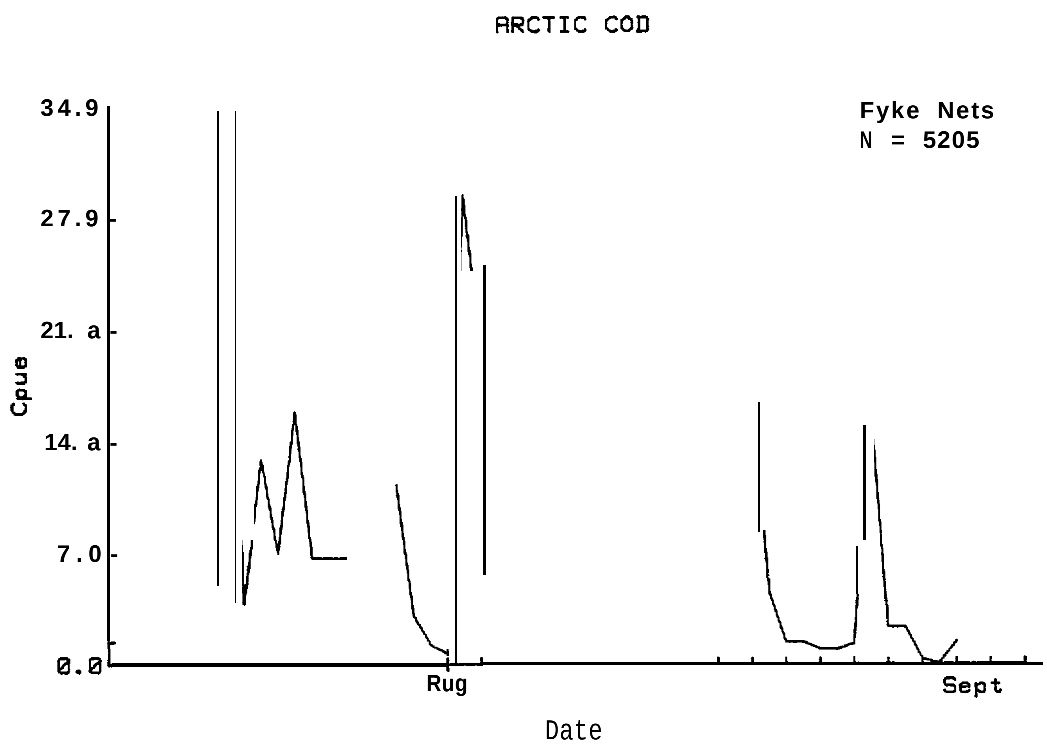


Figure 6-1. Daily catch rate (fish/h) of Arctic cod taken by Point Lay fyke nets during July-August 1983.

monomodal at 65-69 mm (Fig. 6-2). Length was not significantly ($P<0.05$) different among Stations 2. 3 and 4 (ANOVA). Results from Station 1 were not used in any analyses because of the small sample size (N=2).

Point Lay fyke nets took cod ranging from 40-265 mmFL (Fig. 6-3). The 18-27 July catch was dominated by small cod (~55-120 'm 'L) whose length-frequency distribution had a modal peak at 75 mm. The presence of larger fish was more evident during the 28 July-4 August and 19-31 August periods, however, in both cases smaller individuals were still most abundant. The latter sampling period was marked by a distinctive mode at about 95-110 mm.

Otter-trawled cod ranged from 30-205 mm FL, however, the majority of fish were less than 120 mm (Fig. 6-4). Data from certain stations (3, 4, 5 and 6) suggested the presence of a smaller size cohort near 45 mm. Most large specimens were taken at depths greater than 40 m (Stations 4, 5, 20 and 27) and at Station 13 (20 m).

Lowry and Frost (1981) found length-frequency distributions for cod taken in the Beaufort and Chukchi seas during August-September similar to that for our otter-trawled fish. Their age analyses placed 1+ Arctic cod at 71 mm with a length-frequency mode at 70-85 mm. One year old cod from Simpson Lagoon averaged 84 mm (Craig and Haldorson 1981). If we assume our 85 mm cohort to be 1+ fish and further assume a preceding year growth increment of 34 mm (Lowry and Frost 1981) then the 45 mm cohort observed at Stations 3-6 may well contain young-of-the-year spawned in winter 1982-83. These fish may be expected to be in the vicinity of 65 mm (winter data) by March.

6.1.2 Dietary Analyses

6.1.2.1 Winter Study. A total of 73 Arctic cod stomachs were examined. A marked difference in stomach content weight (wet) was noted for fish taken at the three locations. Mean stomach content weight expressed as a percent of stomachless body weight increased as station locations moved southwest; 0.7% at Station 2, 2.2% at Station 3 and 5.0% at Station 4 (Table 6-I). Both ANOVA (subsequent to PROBIT transformation) and Scheffe's test analyses showed the difference to be significant ($P<0.05$) between stations. Regression of stomach content

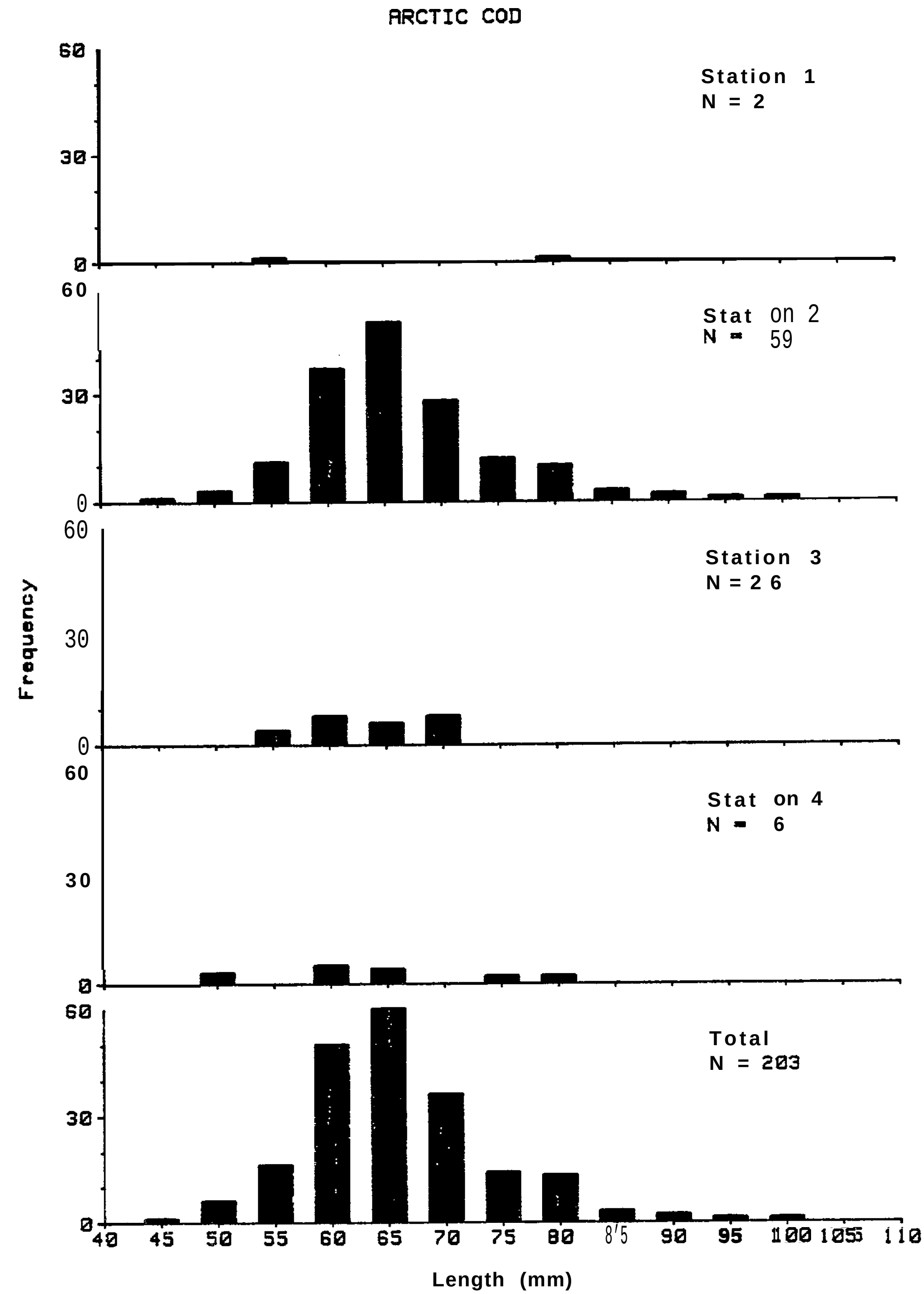


Figure 6-2. Length-frequency distributions for Arctic cod taken during 15-28 March 1983.

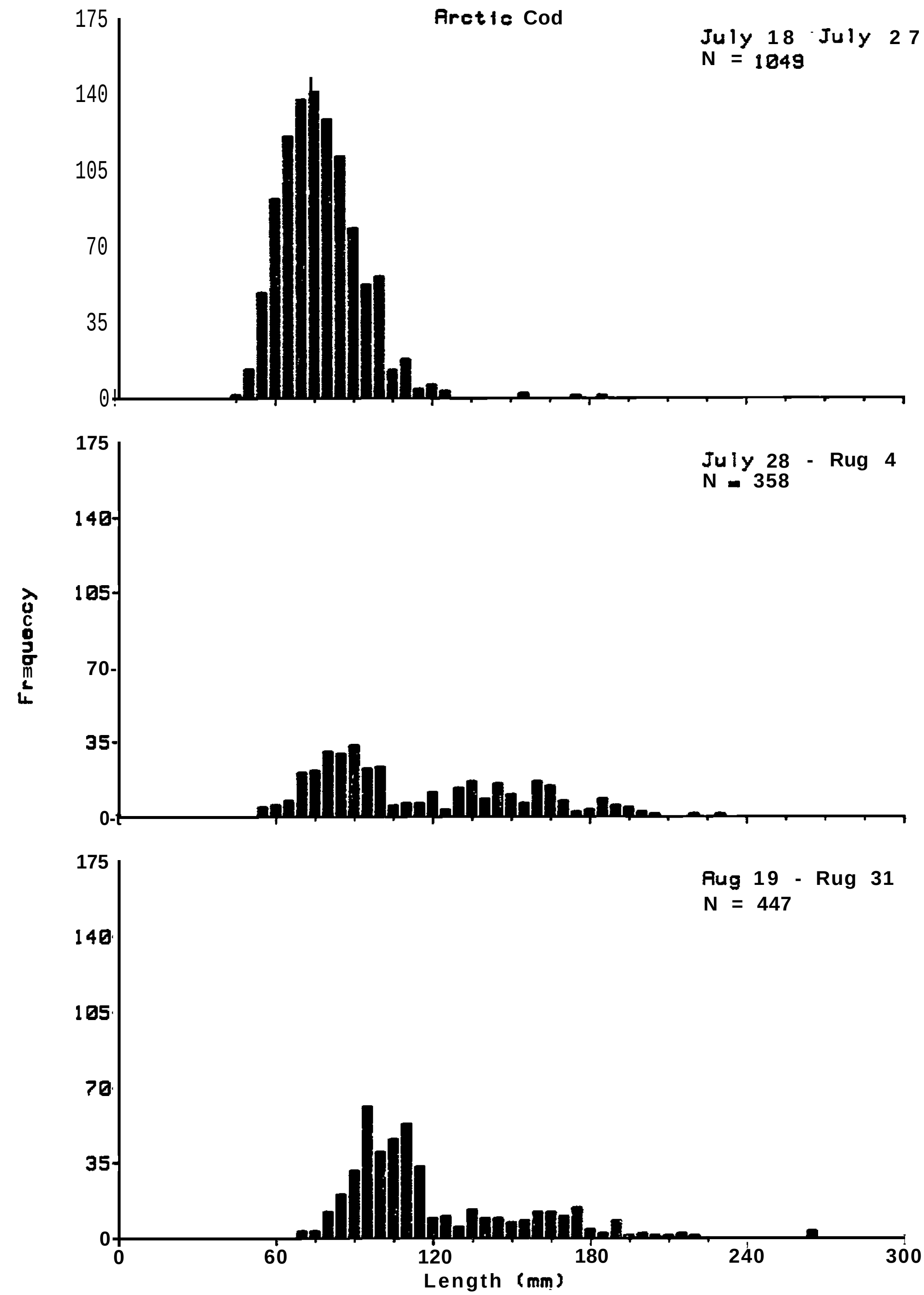


Figure 6-3. Length-frequency distributions of Arctic cod taken by Point Lay fyke nets during July-August 1983.

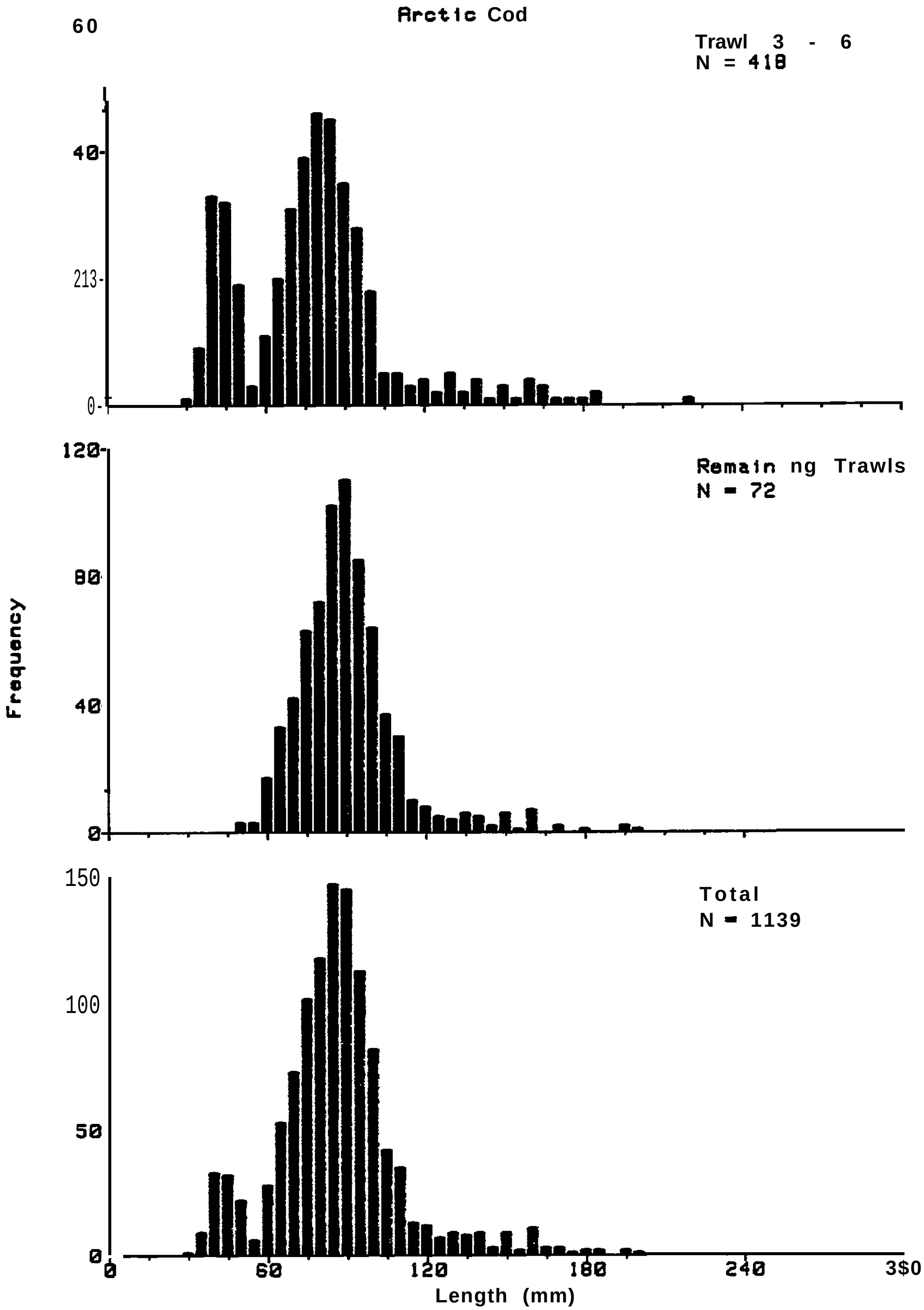


Figure 6-4. Length-frequency distributions of Arctic cod taken by otter trawl during the 25 August-13 September 1983 Discoverer cruise.

weight against stomachless body weight also revealed a significant ($P<0.01$) linear relationship within each station (Fig. 6-5). A test for homogeneity of slopes confirmed significant ($P<0.05$) differences in linear relationships between stations. Within the temporal limits of our sampling regime, Arctic cod taken at Ledyard Bay had consumed significantly more biomass per unit body weight than fish taken at Wainwright while cod from the Wainwright site had, in turn, consumed more biomass than Peard Bay fish.

Table 6-1. Wet weight of stomach contents expressed as a percent of stomachless body weight for Arctic cod taken at Peard Bay (Station 1), Wainwright (Station 2) and Ledyard Bay (Station 3).

Station	N-	Mean	S.D.
1	33	0.67	0.72
2	26	2.22	1.65
3	16	4.96	2.35

To determine if the apparent difference in feeding intensity between locations was indicative of some longer term characteristic, length-weight relationships were analyzed for the three groups. Regressions of natural log (Ln) stomachless body weight versus Ln fork length showed significant ($P<0.01$) linear relationships within stations (Fig. 6-6). Analysis of covariance was performed on body weight using the covariate length, and the adjusted mean weight was found to be significantly ($P<0.05$) different between Stations 2 and 4 and between Stations 3 and 4. There was no significant ($P<0.05$) difference between Stations 2 and 3. Thus, fish in the northern part of the study area had achieved significantly less weight per unit length than fish of the same length from the southern part of the study area.

Identification of stomach contents for Arctic cod taken at Peard Bay was difficult due to the highly digested state of the relatively few organisms present. Of the 33 stomachs examined, 21% (7) were empty and 57% (19) had ≤ 0.01 g of wet weight content. Taxonomic identification was

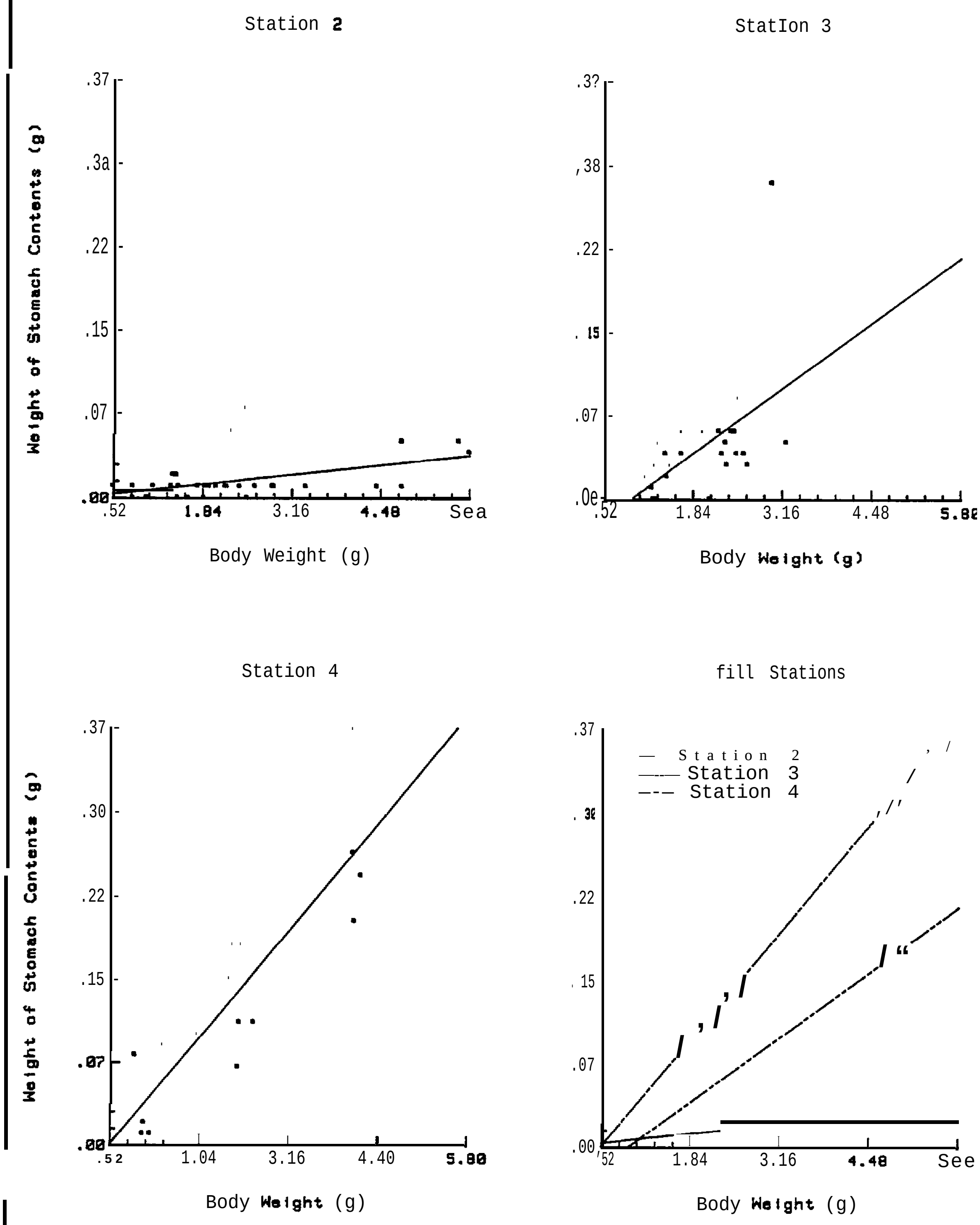


Figure 6-5. Regression plots of stomach content wet weight versus stomachless body weight for Arctic cod caught during the 15-28 March 1983 winter study.

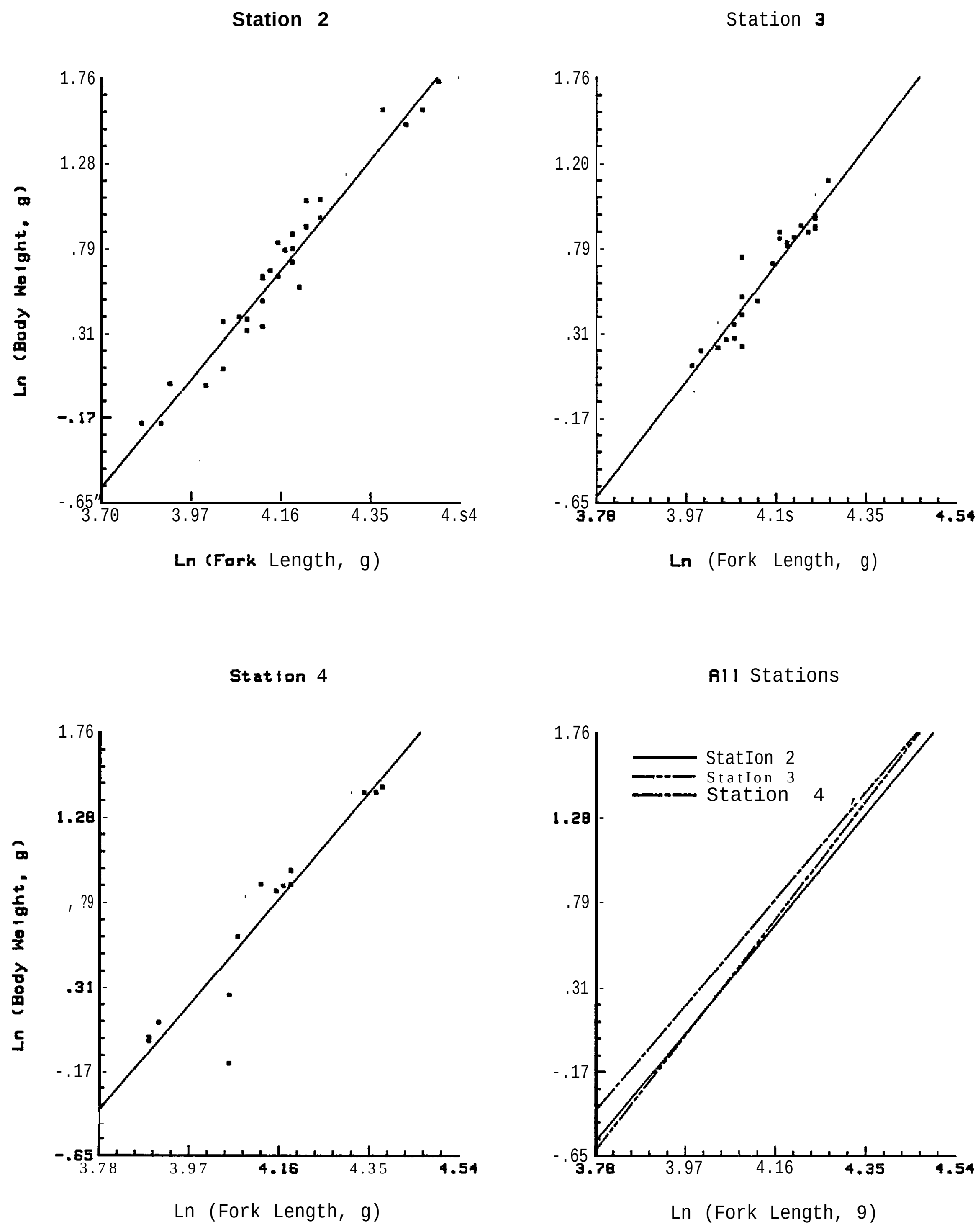


Figure 6-6. Regression plots of natural log (Ln) body weight versus Ln length for Arctic cod caught during 15-28 March 1983.

generally based on the presence of organism parts. This did enable a broad-based classification of major food groups in terms of occurrence, but did not permit a breakdown into biomass content.

In terms of percent occurrence, copepods were identified as the principle food item. They were present in 100% of the stomachs taken from Wainwright (N=24) and Ledyard Bay (N=16), but there was only a 57% (N=19) occurrence in Peard Bay fish. Mysids were present in 38, 25 and 18% of the fish from Peard Bay, Wainwright and Ledyard Bay, respectively. Amphipods occurred less than 10% of the time at Wainwright and Peard Bay, but did occur more frequently (38%) at Ledyard Bay.

Taxonomic classification of food items was more detailed for Arctic cod taken from Ledyard Bay. The planktonic/pelagic copepod, Calanus glacialis was by far the most prominent prey, constituting 85% of wet weight composition. The remaining biomass content was evenly divided between gammarid amphipods and mysids.

6.1.2.2 Discoverer Cruise. The stomachs of 141 Arctic cod taken at 10 different otter trawl stations were examined for content. In order to eliminate fish size as a dietary factor all analyzed specimens were 80-95 mm FL.

Food items varied considerably between stations (Table 6-2, Fig. 6-7)* Benthic amphipods (Dyopedes sp., Ampelisca macrocephala) and cumacea (Diastylus rathkei) were dominant at Stations 3 (9+10) and 13 while pelagic/planktonic forms like decapod larvae, copepods (Calanus glacialis, Acartia longiremis) and the amphipod Apherusa glacialis were most prevalent at Stations 5, 20, 21 and 27. Both benthic and pelagic/planktonic fauna were observed at Stations 6, 7 and 18.

Arctic cod appear extremely adept at exploiting a variety of food sources and trophic niches. As pointed out by Lowry and Frost (1981), this trophic adaptatiliby may contribute to their overwhelming success in arctic marine waters.

6.1.3 St. Lawrence Island

Twenty Arctic cod taken off the mouth of the Fossil River ranged in size from 146-214 mm. All were males of uncertain reproductive status--at least several were considered to be immature fish based on a testes weight

Table 6-2. Stomach contents of Arctic cod (80-95 mm FL) taken by otter trawl during the 1983 Discoverer cruise. Values are percent total wet weight content followed parenthetically by the number of occurrences.

	Station									
Stomach Contents	3 (N=15)	5 (N=15)	6 (N=15)	7 (N=15)	9+10 N· 11)	13 (N=15)	18 (N=9)	20 (N=15)	21 (N=15)	27 (N=15)
Amphipod				6 (5)			1 (1)	• (1)	5 (3)	2 (1)
Dyopedes sp.	75 (15)									
Protomedeia grandimana	• (1)				• (2)	• (1)				
Acanthospephia incarinata					3 (2)					
Pontogeneia rostrata					• (1)					
Monoculodes zernovi	• (2)		1 (2)		5 (2)	-				2 (1)
Ampelisca macrocephala	3 (3)				• (1)	85 (15)				13 (1)
Byblis gaimardi						3 (5)	• (1)			
Photes fischmannis	1 (3)				* (1)					
Podoceropsis sp.		-			• (1)					2 (1)
Apherusa glacialis		11 (1)	28 (1)							
Atylus sp.								• (1)	-	
Anonyx nugax									1 (1)	
Rhachotropis sp.	2 (1)									
Copepod		-		2 (3)						35 (7)
Calanus glacialis		65 (15)	34 (lo)	20 (5)		• (1)		97 (15)	2 (2)	
Acartia longiremis									52 (14)	
Pseudocalanus sp.									4 (3)	
Cumacea			• (1)	4 (3)			2 (1)		18 (2)	-
Diastylus rathkei	1 (2)		5 (2)	5 (1)	72 (9)	• (1)	• (1)		12 (1)	2 (1)
Diastylus edwardi	13 (11)				7 (4)	• (1)				
Eudorella sp.			* (1)			• (1)	• (1)			
Diastylus sp.				33 (8)						
Saggita elegans		* (2)						• (1)	1 (1)	
Fish		12 (2)	3 (1)			7 (1)	47 (3)			
Mysis				14 (3)	-		4 (1)		-	
Mysis littorals	1 (2)	1 (1)	24 (4)	13 (3)	6 (4)		43 (4)		2 (1)	
Decapod larvae		7 (10)	• (1)	• (1)		* (1)		• (1)		40 (5)
Shrimp larvae			1 (1)							

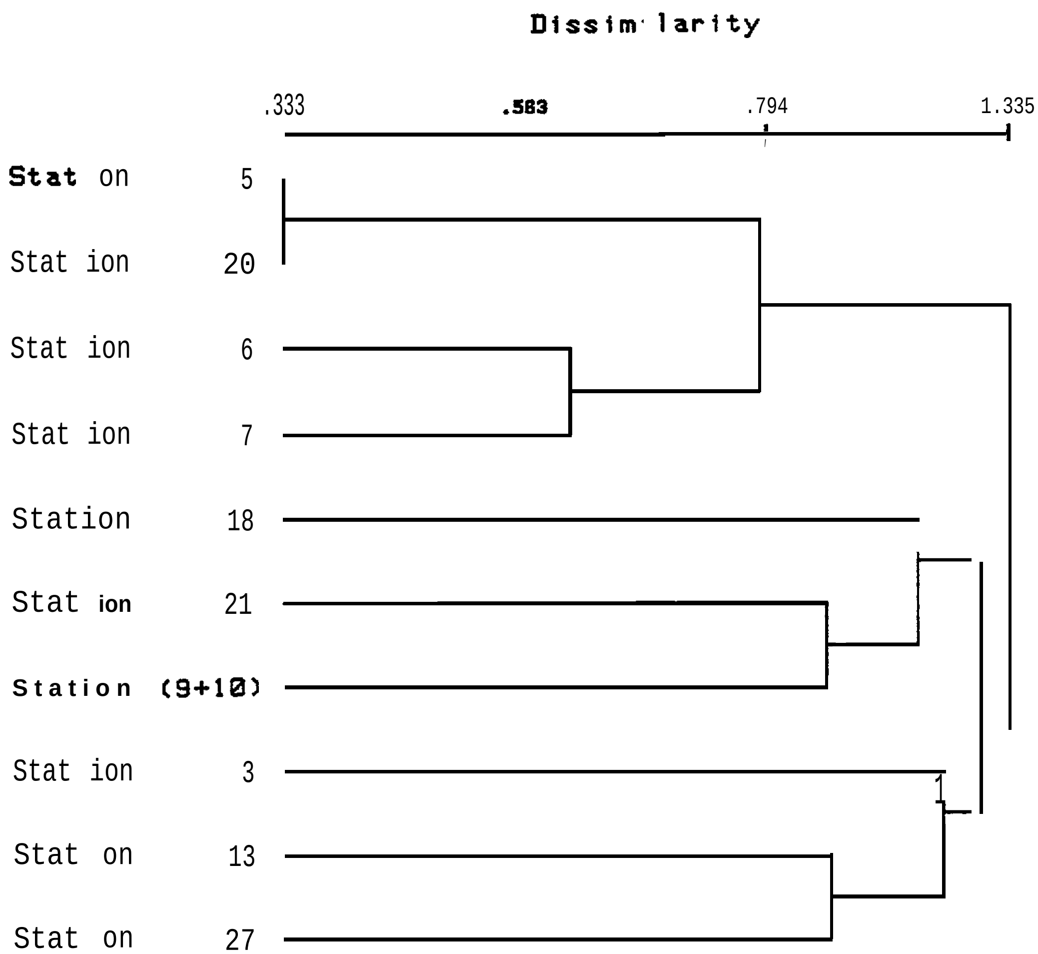


Figure 6-7. Cluster analysis dendrogram for 10 otter trawl stations based on stomach content of 80-95 mm FL Arctic cod.

of less than 0.1 g, while others appeared spawned out. The Arctic cod had little food (average 0.2 g) in their stomachs and of identifiable items, copepods (47%), decapods (45%) and amphipods (7%) were most prevalent.

6.2 Fourhorn Sculpin (*Myoxocephalus quadricornis*)

The fourhorn sculpin is a circumpolar marine spawner that is extremely tolerant of low salinities (Percy 1975. Kendall et al. 1975). They typically overwinter in deep, offshore waters and migrate into nearshore, brackish areas during summer to feed. Overwintering may also occur in the deltas of large river systems (Kogl and Schell 1974, Craig and Haldorson 1981).

In the nearshore waters of the Alaskan and Canadian Beaufort Sea, the fourhorn sculpin is one of the most abundant species (Griffiths et al. 1975. Kendall et al. 1975, Griffiths et al. 1977, Bendock 1979, Craig and Haldorson 1981, Griffiths and Gallaway 1982, Griffiths et al. 1983). This was also the case in lagoon and nearshore waters in the vicinity of Point Lay. This species ranked third in numerical dominance, being exceeded only by Arctic cod and capelin.

The average daily catch rates of fourhorn sculpin taken by fyke net are shown in Figure 6-8. Daily catch varied markedly throughout the season with sharp spikes in CPUE occurring on 19-23 July, 3 August, 20 August and 27-28 August. This trend again corresponds with the water quality differences described in the Catch Summary, Section 5.3.2. The tendency for fourhorn sculpin to prefer nearshore areas during summer is evidenced by comparing the Point Lay and *Discoverer* catch data. While nearly 20% (2845 fish) of the Point Lay catch consisted of fourhorn sculpin, this species accounted for only 4 of 7747 total fish taken by otter trawl in offshore waters. The four individuals were caught 1.6 km off Point Lay at Station 10. All 10 fourhorn sculpin caught by *Discoverer* gill nets came from Station 7 located 1.6 km off Wainwright.

6.2.1 Size

Sculpin taken at Point Lay ranged in total length from 35-275 mm. All of the 202 fish taken by gill net exceeded 80 mm in length (Fig. 6-9), while fyke nets took fish ranging in size from 35-265 mm (Fig. 6-10). The

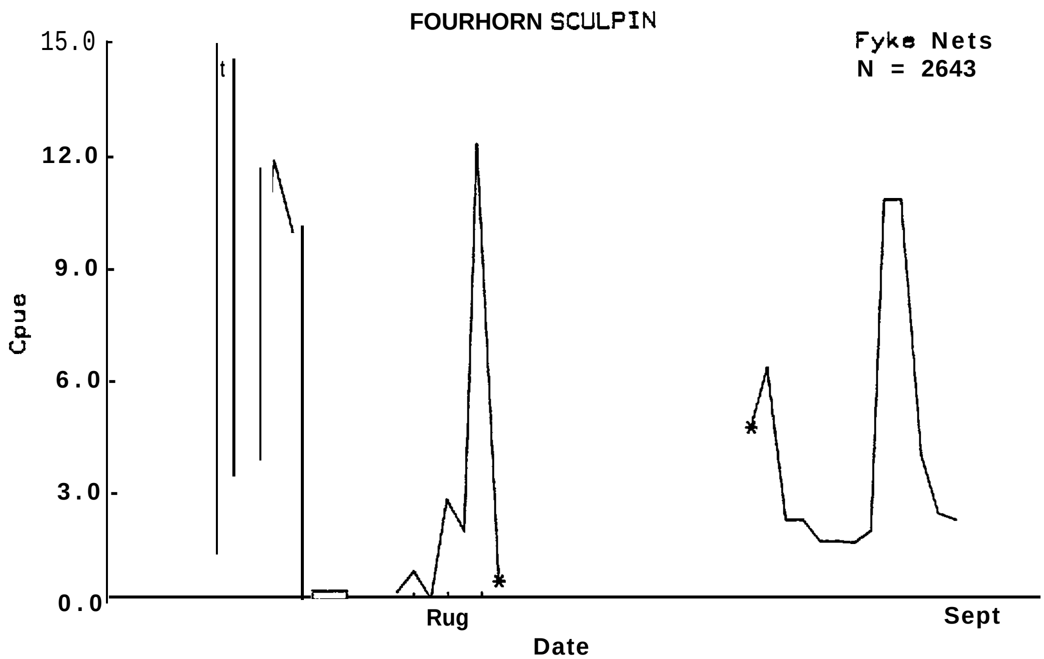


Figure 6-8. Daily catch rate (figh/h) of fourhom sculpin taken by Point Lay fyke nets during July-August 1983.

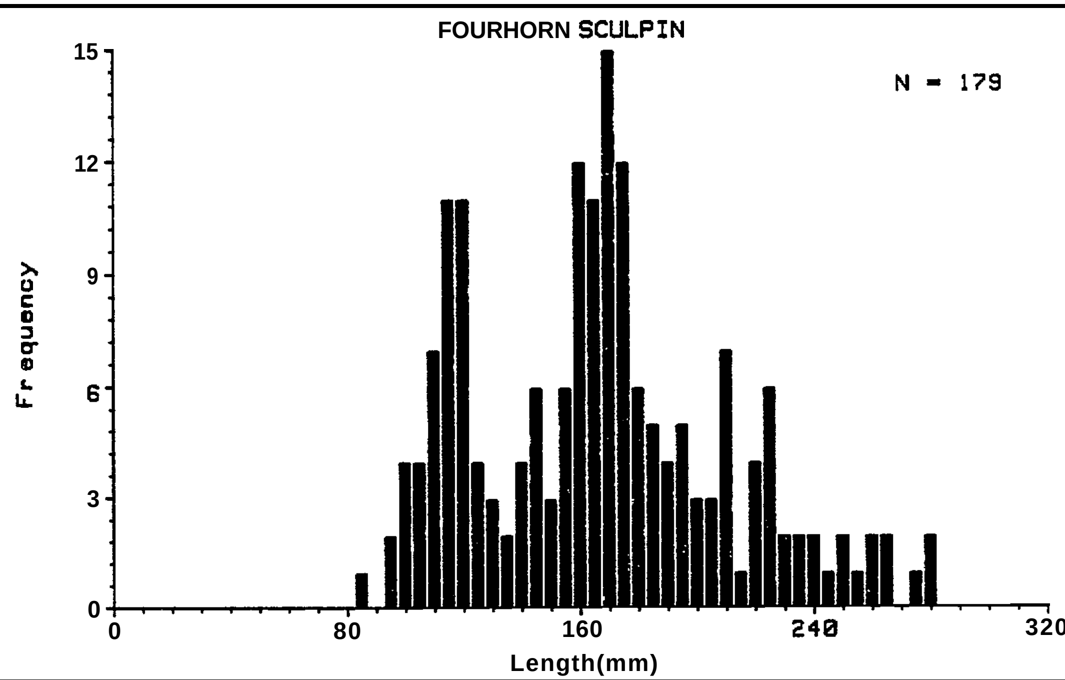
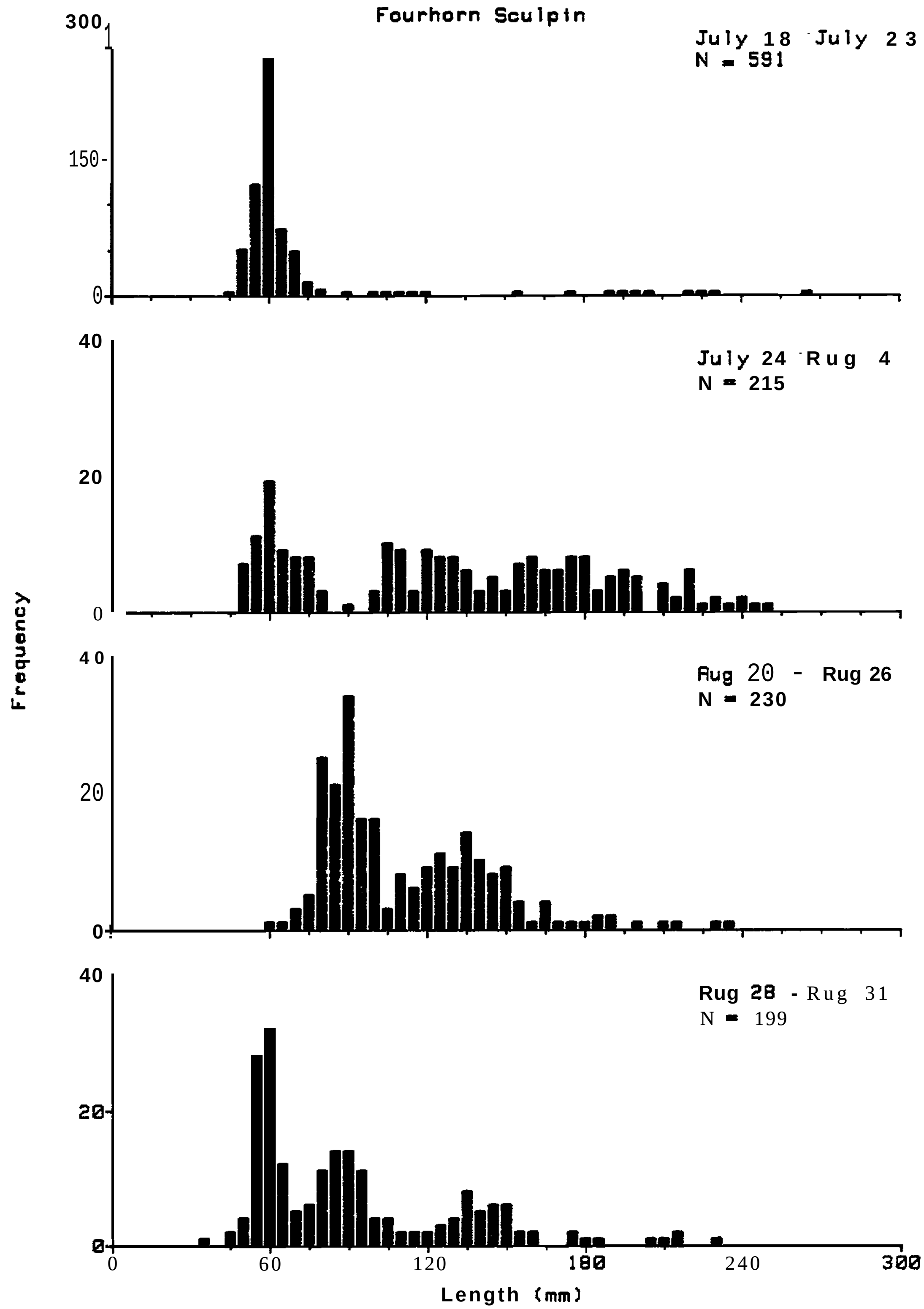


Figure 6-9. Length-frequency distribution of fourhorn sculpin taken by Point Lay gill nets during July-August 1983.



Fiture 6-10. Length-frequency distributions of fourhorn sculpin taken by Point Lay fyke nets during July-August 1983.

most dramatic presence of a dominant size cohort is in the 18-23 July ocean fyke *net* data, Better than 78% of the 591 sculpin measured were 40-80 mm in total length with a distinct modal peak at 60 mm. This group probably represents a one-year-old age class (Craig and Haldorson 1981). From 24 July-4 August there was a more uniform representation of all sizes.

The length-frequency distribution of fourhorn sculpin taken by the lagoon fyke from 20-26 August was bimodal at 90 and 135 mm. Again, assuming similar age-length relationships described by Craig and Haldorson (1981) for Beaufort Sea sculpin, these two size cohorts should denote two and three year old fish. The one year old size class again dominates during the season's last four days (28-31 July). The reason for this smaller cohorts absence from 20-26 August is unclear.

The length-weight regression for fourhorn sculpin taken at Point Lay was :

$$\text{Log Weight (g)} = -6.4+3.6 \text{ Log Length (mm)};\ r^2=0.99,\ N=17$$

$$\text{or Ln Weight (g)} = 14.7+3.6 \text{ Ln Length (mm)}$$

This is similar to the relationship reported for fourhorn sculpin taken at Simpson Lagoon (Craig and Haldorson 1981).

6.2.2 Reproductive Status

Only 16 specimens were examined; 12 of which were females and 4 were males. Gonad weight as percent body weight averaged 5.1% (range: 3.8-10.0%, SD=2.2) for females and 7.1% (range: 4.1-9.0%, SD=2.8) for males.

6.2.3 Food Habits

In terms of percent total wet weight content, fourhorn sculpin (N=31, 115-275 mm TL) fed primarily on the isopod Saduria entomon (65-73%), fish (17-21%) and amphipods (2-4%) (Table 6-3). Empty stomachs occurred 21% of the time. Dietary preference was similar for fish taken on both the lagoon and ocean side of the barrier island. These three food groups were also found in sculpin taken from the Beaufort Sea (Percy 1975; Kendall et al. 1975; Griffiths et al. 1975, 1977; Craig and Haldorson 1981), however, isopods and amphipods were the two prevalent prey. The dominance

Table 6-3. **Food** items of **fourhorn sculpin (115-275** mm **TL) taken by gill** net at Point Lay from 3-29 **August,** 1983. **Values** are Percent wet weight composition followed parenthetically by number of occurrences.

Food Item	Lagoon N = 13		Ocean N = 17	
Plant	● (2)			
Pebble	1 (1)		● (3)	
Unidentified	● (1)		6 (7)	
Ephemoptera nymph	● (1)			
Cirripede larvae	* (1)			
Bivalve	● (1)			
Decapod shrimp			4 (4)	
Polychaete	-		● (3)	
Saduria entomon	81 (9)		65 (17)	
Unidentified **amphipod**	● (1)		● (2)	
Onisimus glacialis	● (1)			
Onisimus littoralis			2 (9)	
Lysianassid	● (1)		● (1)	
Gammarsus setosus	● (3)		1 0	
Pontoporeia affinis	● (2)			
Total **Amphipods**		1 (5)		4 (14)
Mysis littoralis	● (5)		● (1)	
Mysis relicta	● (2)			
Total **Mysids**		* (6)		* (1)
Unidentified fish	6 (3)		8 (3)	
Fourhorn **sculpin**	● (2)		-	
Arctic cod	9 (3)		13 (6)	
Saffron cod			● (1)	
Total Fish		15 (7)		21 (10)

● <1%.

of Saduria entomon in summer is contrary to results reported by Craig and Haldorson (1981). Their study showed amphipods (49%) to be the dominant food item followed by isopods (6%), mysids (6%) and fish (3%). Interestingly, isopods became the major food source during winter (1977-1978:60%, 1978-1979:78%) at Simpson Lagoon.

6.3 Capelin (Mallotus villosus)

The capelin is a marine osmerid with a Pacific distribution throughout Alaska and arctic Alaska (Hart 1973). Spawning takes place in shallow, nearshore areas.

Although capelin was the second most abundant species collected during the Point Lay summer study, all but 2 of 3360 specimens were taken within a three-day period from 1-3 August (Fig. 6-II). No capelin were taken by otter trawl or gill net during the *Discoverer* cruise.

Capelin ranged in size from 110-155 mm FL with a single mode at 130 mm (Fig. 6-12). These fish were slightly larger than capelin caught in Simpson Lagoon in 1979 (Craig and Haldorson 1981).

6.3.1 Reproductive Status

The capelin taken during 1-3 August were apparently part of a spawning population. Egg sizes of ripe or nearly ripe females averaged 0.8 mm mm (range: 0.7-1 mm, N=29) and ovaries of non-spawned individuals averaged 19% (range: 1o-257, SD3.6, N=21) of total body weight. A number of spawned out individuals were also taken. Spawning may have been restricted to the seaward shoreline of the barrier island at Point Lay since no capelin were taken in the lagoon itself (Schmidt and Craig, in press). Paulke (1983) reported that this species spawns earlier (April to July) at various locations in the Bering Sea. In southern British Columbia, capelin spawn in late September or early October (Hart 1973)

6.3.2 Age and Maturity

Capelin mature at an earlier age than almost any other fish species in the Arctic. The spawning population at Point Lay consisted almost entirely (94%) of Age 2 fish (otolith based age), with the remaining 6% being Age 3. All but one male and one female were mature. Paulke (1983)

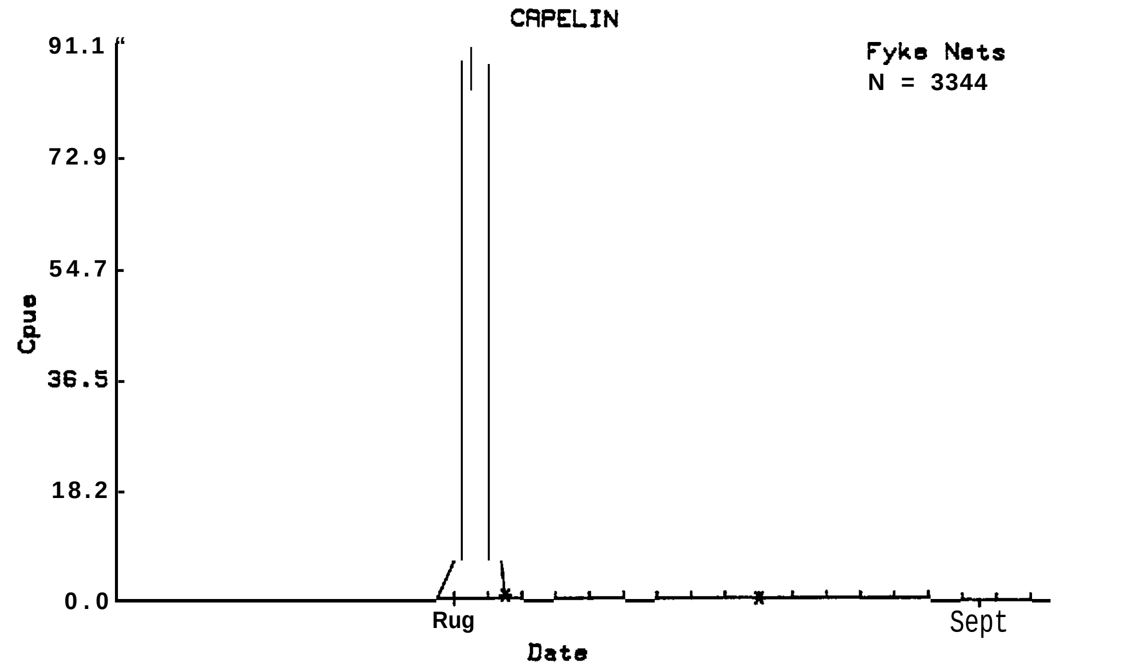


Figure 6-11. Daily catch rate (fish/h) of capelin taken by Point Lay fyke nets during July-August 1983.

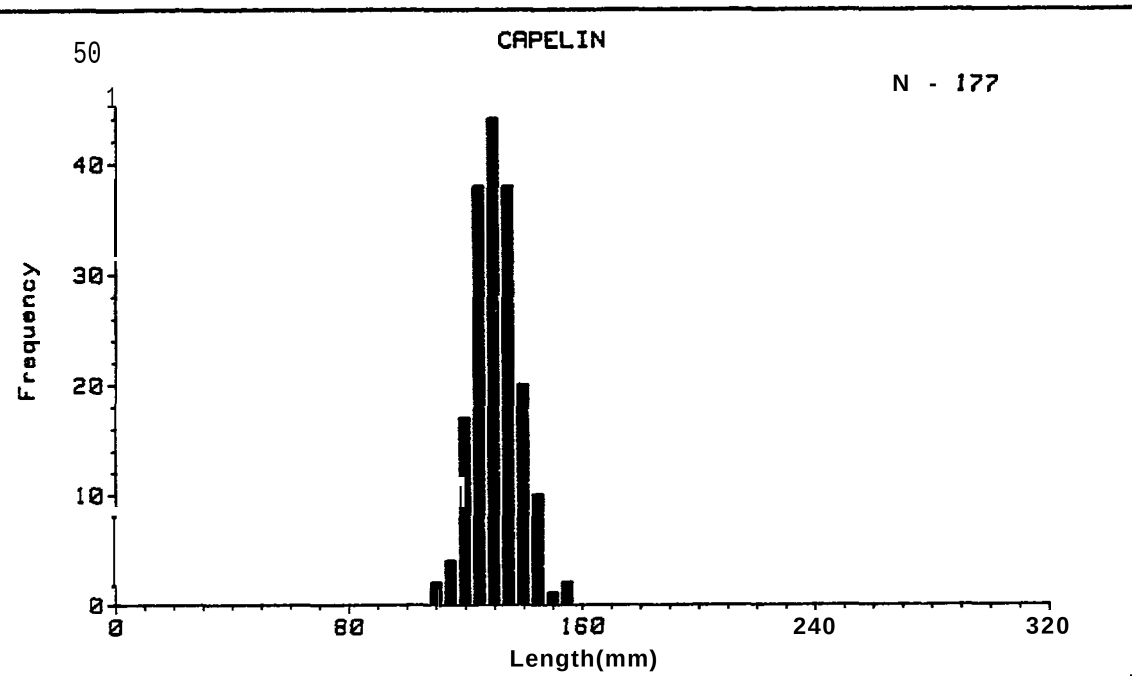


Figure 6-12. Length-frequency distribution of capelin taken by Point Lay fyke nets during July-August 1983.

found that although both age classes spawned in the Bering Sea, three-year-olds were most prevalent.

Males were generally about 10 mm longer than females, a fact also noted by Paulke (1983). At Age 2, females averaged 123.1 mm FL (range: 108-138 mm, SD=6.9, N=36) compared to 134.7 mm for males (range: 127-143 mm, SD=6.1, N=10). The only Age 3 fish in the collection were a 133 mm female and two males, 147 and 152 mm FL.

The length-weight regression for a sample of capelin from Point Lay was :

$$\text{Log Weight (g)} = -7.2+3.9 \text{ Log Length (mm)};\ r^2=0.82,\ N=61$$

$$\text{or Ln Weight (g)} = -16.7+3.9 \text{ Ln Length (mm)}$$

6.3.3 Food Habits

Capelin were the most selective feeders of any of the fish examined. While 60% of the 52 stomachs checked were empty, the remaining 14 contained only one identifiable prey. Mysis littoralis occurred in all 14 stomachs and accounted for -95% of total wet weight content. It should be noted that the capelin examined were taken from fyke net catches and data could reflect unnatural feeding circumstances. Fourhorn sculpin and Arctic cod, for example, feed on fauna which becomes trapped in fyke nets.

6.4 Saffron Cod (Eleginus navaga)

Saffron cod are marine fish which generally inhabit nearshore areas and often enter rivers (Morrow 1980). They spawn annually in nearshore waters during winter. While their distribution is generally limited to the northern Pacific Ocean, Bering and Chukchi seas, small numbers are present in the Canadian and Alaskan Beaufort Sea (Percy 1975, Kendall et al. 1975, Bendock 1977, Craig and Haldorson 1981, Griffiths and Gallaway 1982- Griffiths et al. 1983).

The 269 saffron cod takenat Point Lay constituted less than 2% of the total catch. Taken primarily (99%) by fyke net, the catch during the 18 July-4 August sampling period was essentially limited to26 July, 1

August and 3 August (Fig. 6-1 3). A more consistent daily catch was noted during the latter half of' August.

Length-frequency distributions differed between the two summer sampling periods at Point Lay (Fig. 6-14). From 18 July-4 August the distribution was monomodal at 90 mm with a size range of 80-125 mm FL. The distribution was hi-modal during 19-31 August with approximate modes at 70-75 mm and 120 mm. Fish from the smaller size cohort were taken primarily on 28 and 31 August.

Otolith aging was not performed on saffron cod caught during this study; however, determinations made by Craig and Haldorson (1981) for specimens taken in Simpson Lagoon indicated a length range of 79-192 mm for Age 1 fish and 145-242 mm for Age 2 fish. They concluded that the growth rate of these fish were generally similar to that reported for young saffron cod in Siberia (Andriyashev 1954). While growth rates for a particular species may be expected to vary with geographic location, it is likely that the 45-75 mm size cohort which appeared in Point Lay on 28 and 31 August represents young-of-the-year for this winter spawning species.

The length-weight regression for a sample of saffron cod taken from Point Lay was:

$$\text{Log Weight (g)} = -5.3+3.1 \text{ Log Length (mm)}; r^2=0.99, N=16$$
$$\text{or Ln Weight (g)} = -12.1+3.1 \text{ Ln Length (mm)}$$

All of the saffron cod caught during the Discoverer cruise were taken by otter trawl. Fifth in numerical abundance, the 1090 specimens represented 5% of total catch. Most (83%) of these fish were taken at four locations--72 at Station 12 (Utokuk Pass), 106 at Station 21 (Ledyard Bay), 491 at Station 22 (Ledyard Bay) and 263 at Station 29 (50 km SE of Point Hope). Length-frequency distributions at the four sites were monomodal at about 60-65 mm FL (Fig. 6-15) which is similar to the smaller, and presumably young-of-the-year, cohort fyke-netted at Point Lay during the last few days of August.

Three sexually mature saffron cod were taken at trawl Station 29--two females (260, 280 mm) and one male (300 mm). No specimens were taken by Discoverer gill nets.

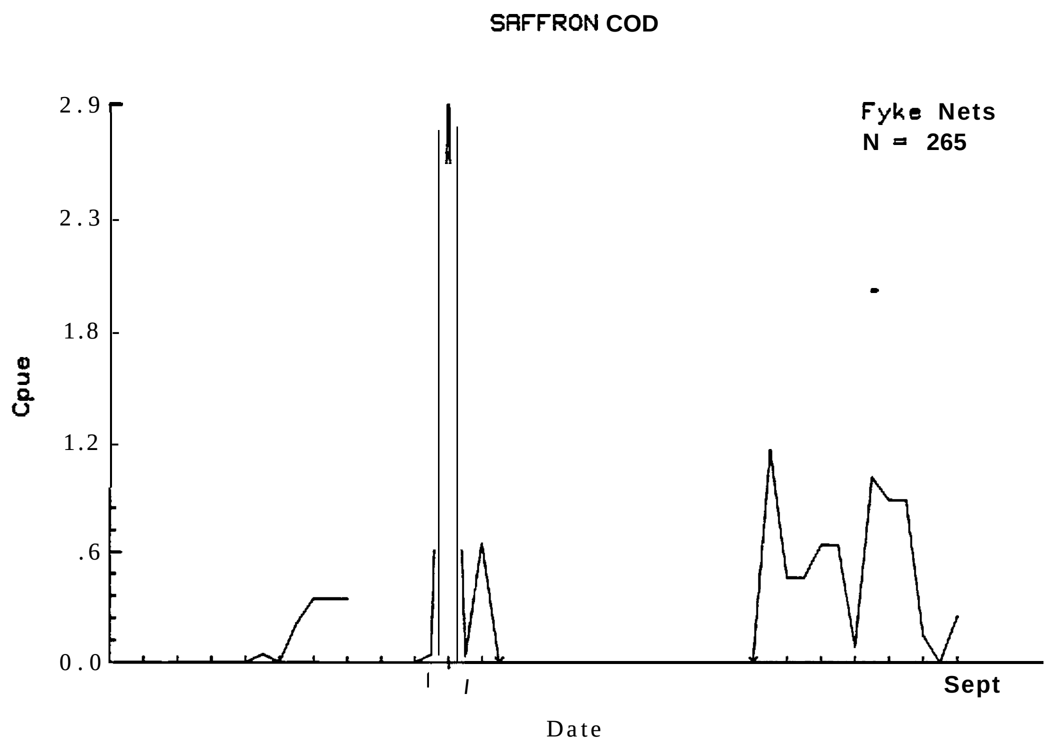


Figure 6-13. Daily catch rate (fish/h) of saffron cod taken by Point Lay fyke nets during July-August 1983.

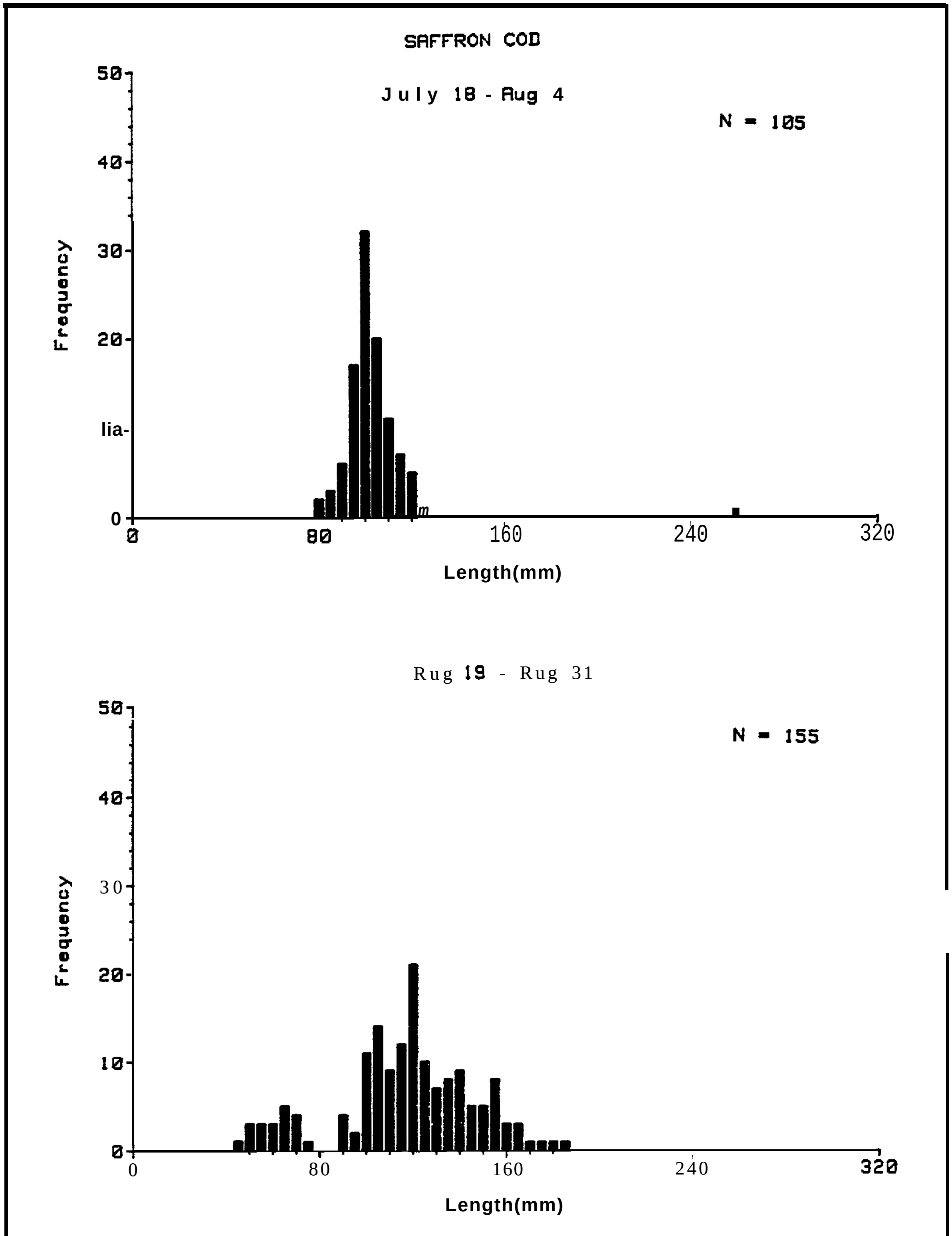


Figure 6-14. Length-frequency distributions of saffron cod taken by Point Lay fyke nets during July-August 1983.

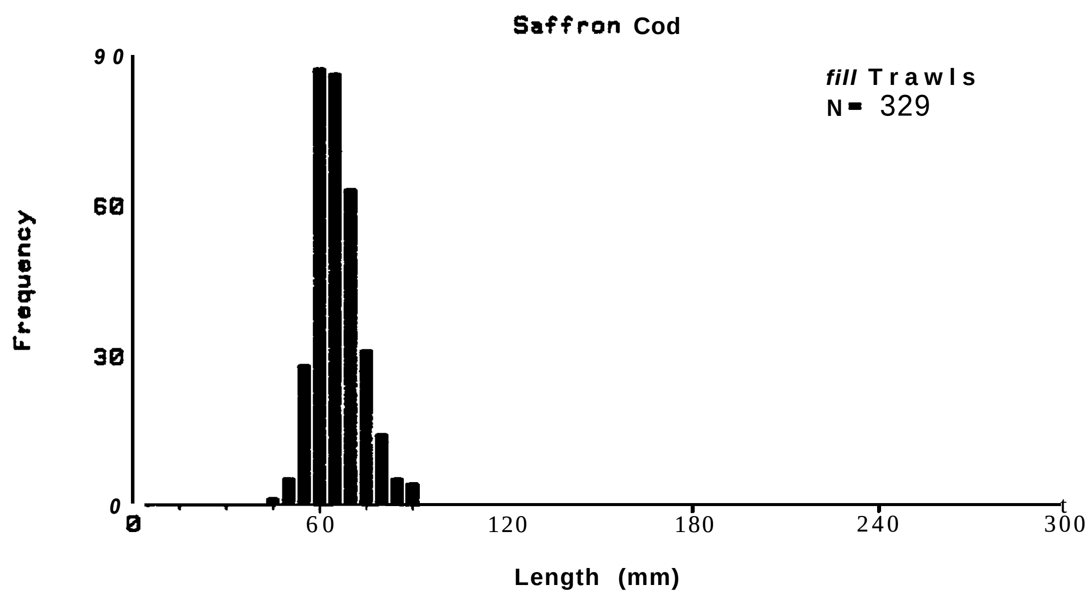


Figure 6-15. Length-frequency distributions of saffron cod taken by otter trawl during the 25 August-13 September 1983 Discoverer cruise.

6.4.1 Kotzebue

The sample consisted almost entirely of large, mature fish that were approaching a spawning condition. The average fork length was 238 mm (n=33, range=207-283 mm). Most were females (79) and all but one of each sex were mature. Egg diameters of females averaged 0.9 mm (n=11, SD=0.16, range=0.6-1.1 mm).

Only three fish (9%) in the Kotzebue sample had empty stomachs; the rest had eaten fish (68% total wet weight content), mysids (18%), mostly Neomysis rayii, and decapods (13%).

6.4.2 St. Lawrence Island

Twenty saffron cod were jigged through the ice near St. Lawrence Island in February 1983. They ranged in size from 231-345 mm FL (mean 290 mm, SD=31.5) and all were spawned out males. Most were 3-6 years of age, with two fish tentatively aged at 2 (otoliths were broken and burned to determine ages). These fish had eaten well as indicated by the amount of food in their stomachs (average 4.2 g of ingested food). Major food items were gammarid amphipods (58% of total wet weight content), fish (21%), mostly saffron cod and sculpins, and polychaetes (16%).

6.5 Pacific Herring (Clupea harangus pallasii)

The Pacific herring is a marine fish which is distributed along the North American coast from Cape Bathurst in the Canadian arctic to as far south as Baja, California (Hart 1983). The bulk of the population lies south of the Bering Straits and has been commercially exploited since the early 1900's. Population density in the Chukchi appears to be low and attempts to develop a herring fishery have been unsuccessful.

Spawning grounds are usually located in high energy, nearshore environments with spawn being deposited on vegetation or on bottom substrate which is free from silting (Haegele and Schweigert 1983). Pacific herring are spring spawners and spawning occurs earlier in the year for more southerly populations.

Except for four individuals taken by otter trawl, all of the herring caught at Point Lay and during the Discoverer cruise were taken by gill net. At Point Lay the 527 Pacific herring ranked fifth in abundance among all fish caught. Pacific herring were taken at 11 of 14 Discoverer gill-net stations with 14 of 46 total fish coming from Station 14 located 20 km off the Ledyard Bay coast.

6.5.1 Size.

With the exception of a single 120 mm individual, Pacific herring taken at Point Lay rangedin size from 205-295 mm FL (Fig. 6-16). Their length-frequency distribution was monomodal at 260 mm. Specimens taken by Discoverer gill nets ranged in size from 185-290 mm FL with 90% of the fish measuring $\leq$225 mm or $\geq$260 mm.

The length-weight regression for a sample of Pacific herring taken at Point Lay was:

$$\text{Log Weight (g)} = 4.0 + 2.6 \text{ Log Length (mm)}, \; r2=.45, \; N=82$$

$$\text{Ln Weight (g)} = -9.2 + 2.6 \text{ Ln Length (mm)}$$

6.5.2 Reproductive Status

Both sexes were well represented in both the Point Lay (34 males, 48 females) and Discoverer (17 males, 18 females) samples.

There is evidence that herring may have spawned in the Kasegaluk Lagoon area during early summer. Gonad weight (as % body weight) for males (Fig. 6-17) and females (Fig. 6-18) increased from low levels during August (Fig. 6-17). Eggs were miniscule (~0.1-0.2 mm) at the beginning of the month but averaged 0.5 mm (range 0.2-1.0, SD=0.2, N=14) for females taken after 23 August. Hay (1983) reported that most British Columbia herring begin sexual maturation in late summer and become sexually mature in the subsequent spring.

There was no trace of young-of-the-year herring throughout the end of the summer at Point Lay. Morris (1980) states that young herring may attain sizes up to 100 mm during their first summer, however, this figure is probably associated with more southerly populations which spawn earlier and inhabit warmer waters. Young fish may have been too small for our fyke nets or may have moved offshore.

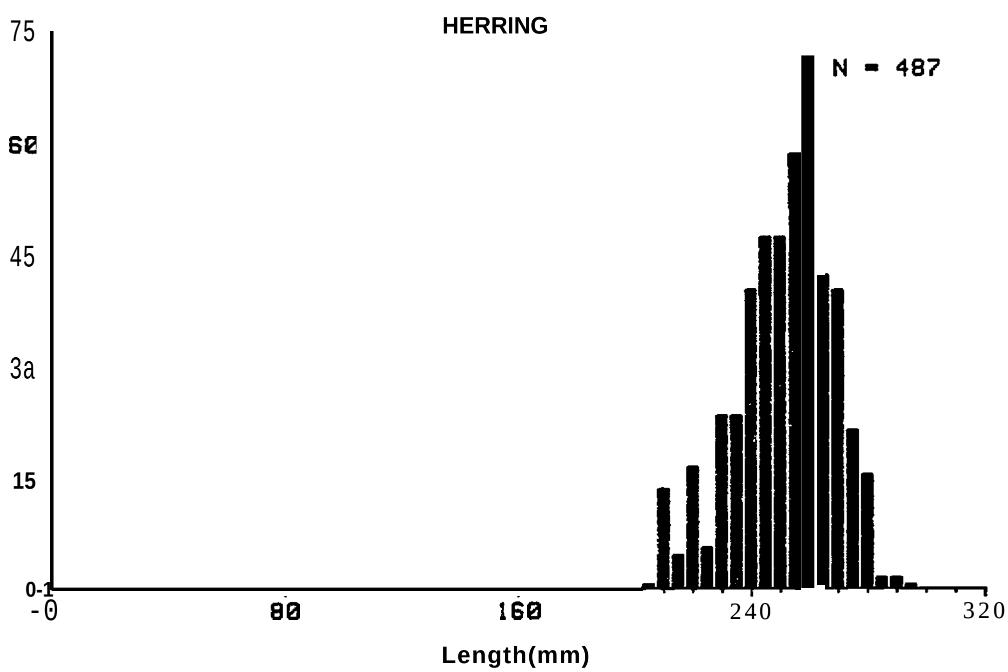


Figure **6-16.** Length-frequency distribution of Pacific herring taken by Point Lay gill nets during July-August 1983.

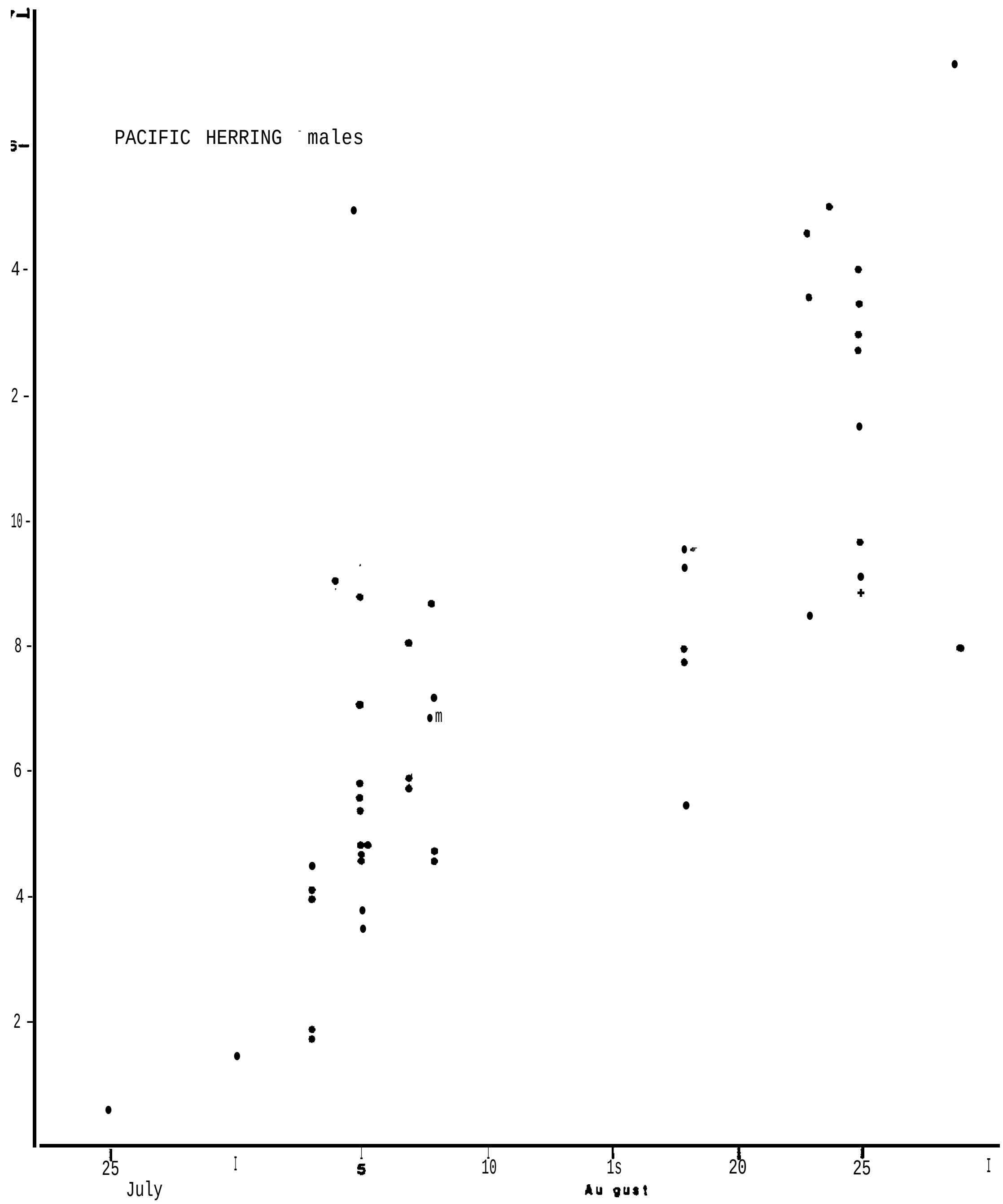


Figure **6-17.** Gonadosomatic index (teste weight/body weight) for male Pacific herring taken at Point Lay in 1983. Included are specimens reported by Schmidt and Craig (in press).

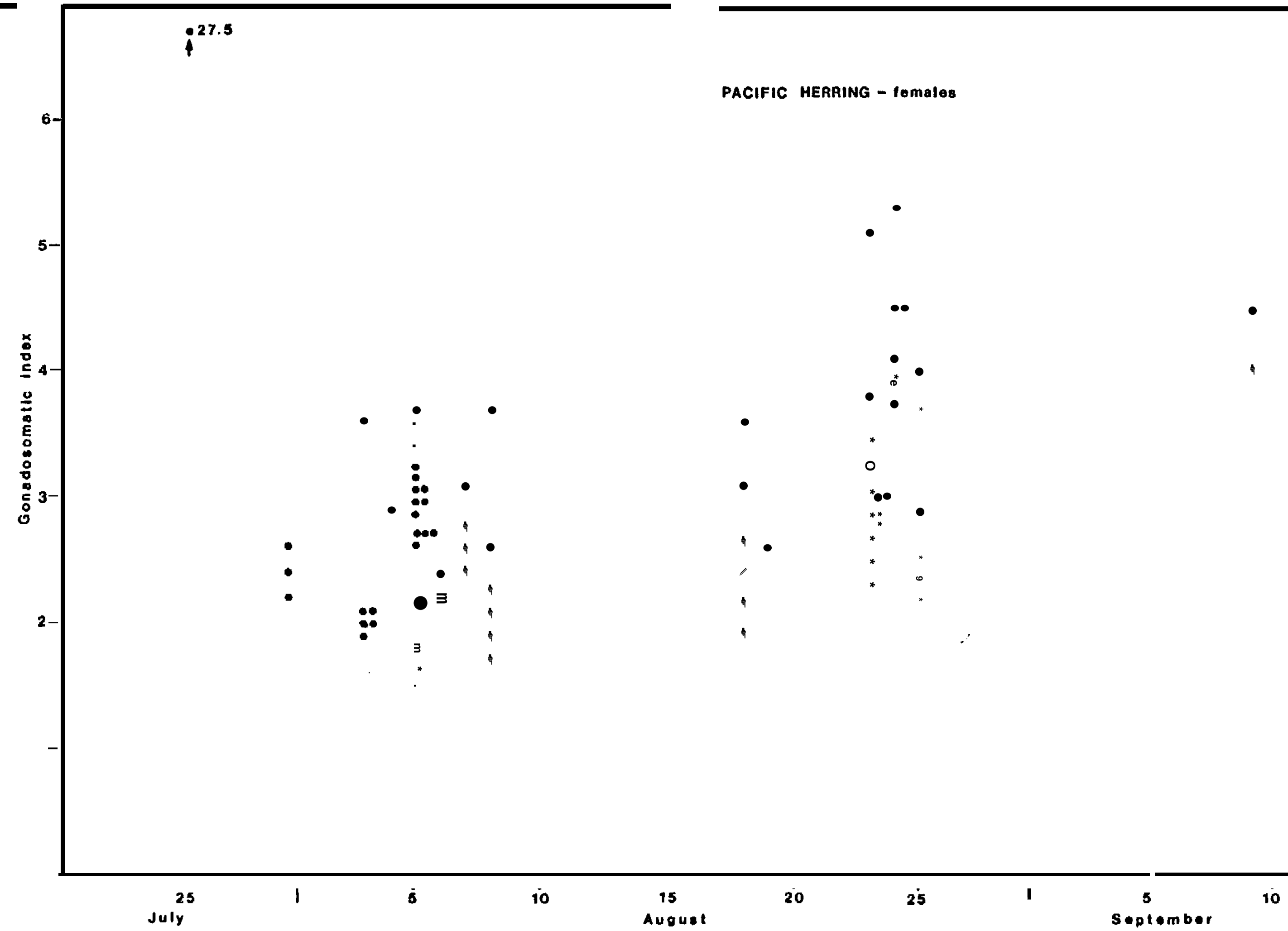


Figure 6-18. Gonadosomatic index (ovary weight/body weight) for female Pacific herring taken a= Point Lay in 1983. Included are specimens reported by Schmidt and Craig (in press).

6.5.3 Feeding Habits

Pacific herring (210-285 mm FL) gill-netted during the Point Lay study fed primarily on Mysis littoralis and, to a lesser extent, fish (Table 6-4). Opportunistic feeding patterns are evident when the diets of fish caught on the seaward side of the barrier islands are compared with individuals gill-netted in the lower reaches of the Kokolik River (Schmidt and Craig, in press). The calanoid copepod Temora sp. accounted for 56% of stomach content in river-caught fish, with mysids and fish larvae constituting 17% each. Temora sp. were totally absent from in-ocean-caught herring and Mysis littoralis became the dominant mysid representative.

6.6 Boreal Smelt (Osmerus mordax)

The boreal smelt lives in marine and brackish water but returns to freshwater streams and lakes to spawn. Their arctic distribution extends from Vancouver Island around Alaska to Cape Bathurst in the Canadian arctic (Hart 1973).

A total of 304 boreal smelt were captured during the Point Lay study--134 by fyke net and 170 by gill net. Among all fish, they ranked seventh in abundance and made up 2.2% of the total catch. There was a marked absence of smelt in late July. All but one of the fyke-netted smelt were captured at Station 2 (lagoon) after 19 August (Fig. 6-19) and only six individuals were gill-netted prior to 3 August.

Smelt were not caught far offshore. Station 3, located 1.5 km offshore, caught only one individual during a total of 14.6 net-days (bottom and surface nets), however, they were taken by lagoon and nearshore ocean gill nets. Boreal smelt appear to prefer the bottom of the water column, at least when traveling seaward of the barrier islands. All but one of 77 fish taken at gill net Station 4 (depth 8 m) were caught in the bottom net.

Otter trawls accounted for only one boreal smelt, however, 33 individuals were taken by Discoverer gill nets. Of these, three were captured 1.5 km off Point Lay (Station 1) and the remainder within 1.5 km of Wainwright--28 at Station 7 (0.75 km) and two at Station 8 (1.5 km).

Table 6-4. Food items of Pacific herring (210-285 mm FL) taken by gill net at Point Lay during summer 1983. Values are percent wet weight composition followed parenthetically by number of occurrences.

Food Item	Ocean: 3-5 August N=11	River[1]: 5 August N=18	Ocean: 24-29 August N=25
Plant		• (11)	• (7)
Pebble	-	9 (2)	* (3)
Unidentified	19 ([illegible]	- (11)	* (2)
Errant polychaete			* (2)
Cumaces	• (1)	-	6 (5)
Saduria entomon	* (1)		-
Calanoid	6 (1)	* (1)	-
Calanus glacialis	* (1)	* (1)	-
Temora sp.	-	56 (8)	-
Cyclopoid	-	* (1)	* (1)
Harpactecoid	-	* (9)	* (1)
Total Copepods	6 (2)	57 (18)	
Unidentified amphipod	* 2	I	-
Onisimus littoralis	-	I	* (3)
Lysianassid	-	2)	• (2)
Oediceroid	-	*	• (2)
Pontoporeia affinis	-	-	* (2)
Total Amphipods	* (2)	* (2)	* (5)
Unidentified mysid	-	• (3)	* (1)
Mysis littoralis	43 0)	* (1)	81 (20)
Mysis relicta	-	+ (4)	* (2)
Neomysis sp.	-	U (3)	2 (4)
Total Mysids	43 (10)	17 (15)	84 (20)
Fish larvae	24 (2)	7 6	* (3)
Arctic cod	-	-	* (1)
Fourhorn sculpin	7 (1)	-	2 (1)
Sand lance	-	-	5 (2)
Total Fish	31 (3)	17 (6)	8 (7)

[1]Schmidt and Craig (in press).
*<1%.

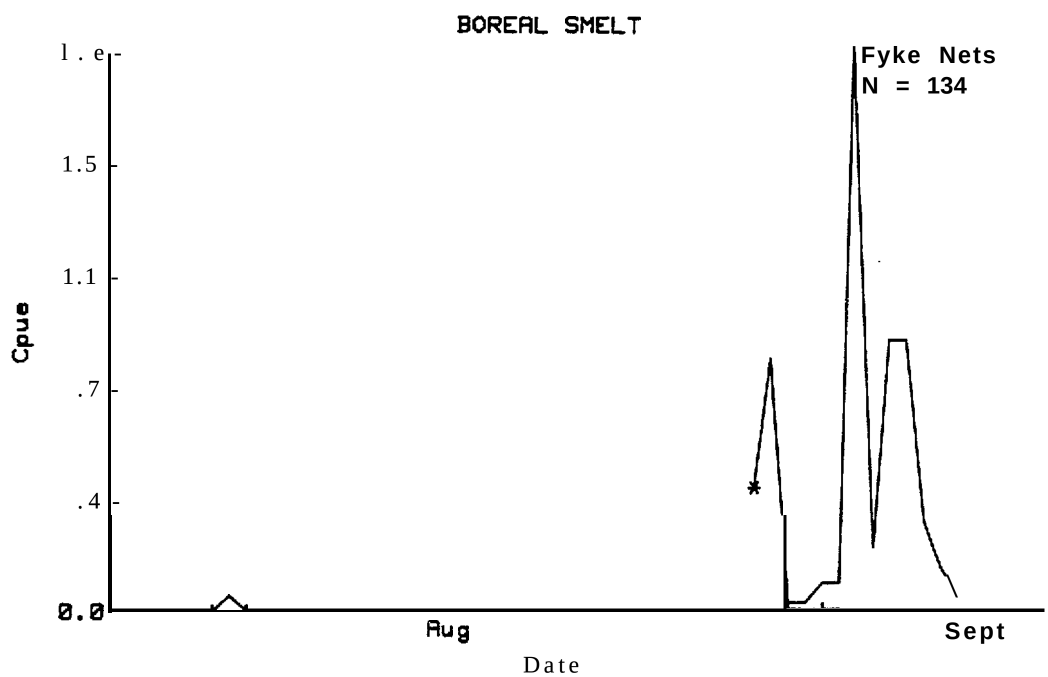


Figure 6-19. Daily catch rate (fish/h) of boreal smelt taken by Point Lay fyke nets during July-August 1983.

Bendock (1977) also reported a concentration of boreal smelt off the Kuk River near Wainwright.

6.6.1 Size and Age

Gill-netted fish taken at Point Lay ranged in size from 120-300 mm FL, however, a strong modal peak was apparent from 220-230 mm (Fig. 6-20). The length-frequency distribution of' boreal smelt captured by fyke net showed a multimodal configuration containing distinct aggregations in the 50-70 mm and the 85-125 mm range (Fig. 6-21). A more even distribution was evident from 195-270 mm. The August catch showed size related variations in daily catch. Fish greater than 130 mm were taken from 19-26 August but were completely absent from 27 August onward. The smaller 50-70 mm size cohort showed up on 28 August until the 31 August conclusion of the sampling effort.

Age analyses were not performed on boreal smelt, however, otolith studies conducted by Craig and Haldorson (1981) indicated approximate length ranges for Beaufort Sea smelt of 56-89 mm and 90-142 mm for Age 0+ and 1+ fish, respectively. North Atlantic and Great Lake populations yield an approximate 1+ length of 111 mm (Morrow 1980). If these characteristics hold *true* for Chukchi smelt then the smallest size cohort observed in our fyke net data may represent young-of-the-year. The lack of young-of-the-year fish in fyke net catches prior to 28 August may reflect gear inadequacies (25 mm mesh leads) rather than the absence of young smelt in Kasegaluk Lagoon. Fry spawned at the beginning of the summer are 5-6 mm in length. The estuary system could, in fact, serve as first-year feeding and nursery grounds.

The length-weight regression for boreal smelt taken at Point Lay was:

$$\text{Log Weight (g)} = -5.9+3.3 \text{ Log Length (mm)};\ r^2=0.98,\ N=58$$
$$\text{or Ln Weight (g)} = -13.6+3.3 \text{ Ln Length (mm)}$$

which is nearly identical for the relationship determined for boreal smelt taken at Simpson Lagoon (Craig and Haldorson 1981).

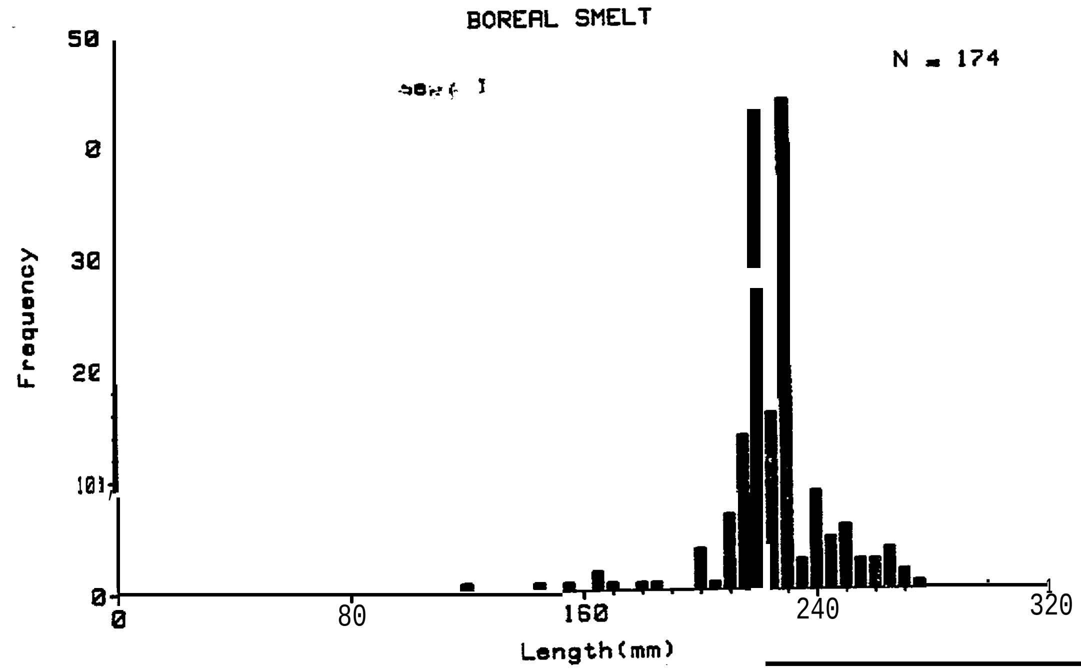


Figure 6-20. Length-frequency distribution of boreal smelt taken by Point Lay gill nets during July-August 1983.

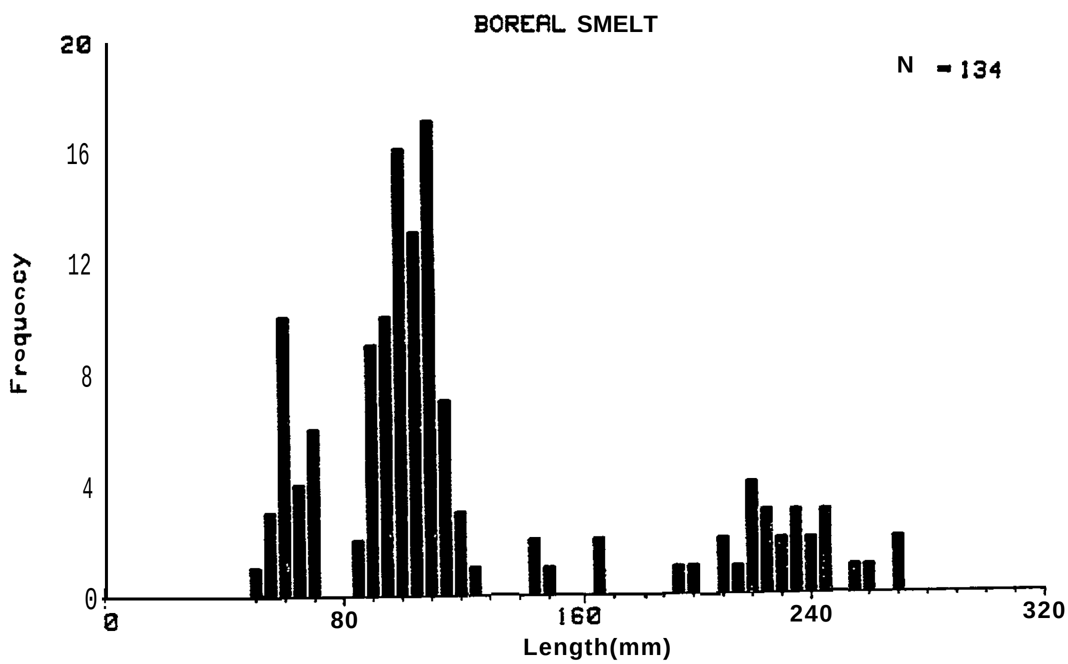


Figure 6-21. Length-frequency distribution of boreal smelt taken by Point Lay fyke nets during July-August 1983.

6.6.2 Reproductive Status

Analyses of reproductive status revealed the following breakdown: 21 sexually mature males (207-280 mm FL), 23 sexually mature females (200-262 mm FL), 9 immature males (104-182 mm FL) and 3 immature females (111-200 mm FL).

Average gonadal weight for mature males averaged 8.1% (range: 4.6-10.2%, SD=2.8, N=21) of body weight, but was only 1.2% (range: 0.7-1.8%, SD=0.6, N=3) in immature fish. These values are much higher than those reported for Beaufort Sea smelt where mature males averaged 3.4-4.9% gonadal weight year-round.

A consistent increase in ovary weight occurred during July and August (Fig. 6-22). This apparent post-spawning gonadal recovery along with the presence of apparent young-of-the-year fish in August, the report of a sexually ripe female near Point Lay in mid-June (Schmidt and Craig, in press) and the fact that boreal smelt do not to undergo extensive coastal migrations (Morrow 1980) make it very likely that the major rivers (Kokolik, Utukok, Kukpowruk) which feed Kasegaluk Lagoon are spawning sites for boreal smelt.

The 33 boreal smelt takenby Discoverer gill nets near Wainwright ranged in size from 195-215 mm FL and all identifiable specimens appeared sexually mature (18 males, 6 females).

6.6.3 Feeding Habits

Stomach analyses of boreal smelt gill-netted from 19-22 August showed them to be strongly piscivorous (Table 6-5). Fish accounted for 65% of total wet weight content, with *Mysis littoralis* (25%) being the only other prominent prey (Table 6-5). The dominance of Arctic cod in their diet reflects the high densities of this species in nearshore water. Schmidt and Craig (in press) likewise found fish (58%) and *Mysis littoralis* to be primary food items during June to early August.

6.7 Arctic Flounder (*Liopetta glacialis*)

The Arctic flounder is a shallow water flatfish not typically found far offshore. Its distribution is almost circumpolar and covers the Canadian and Alaskan Beaufort seas, through the Chukchi Sea, and down the

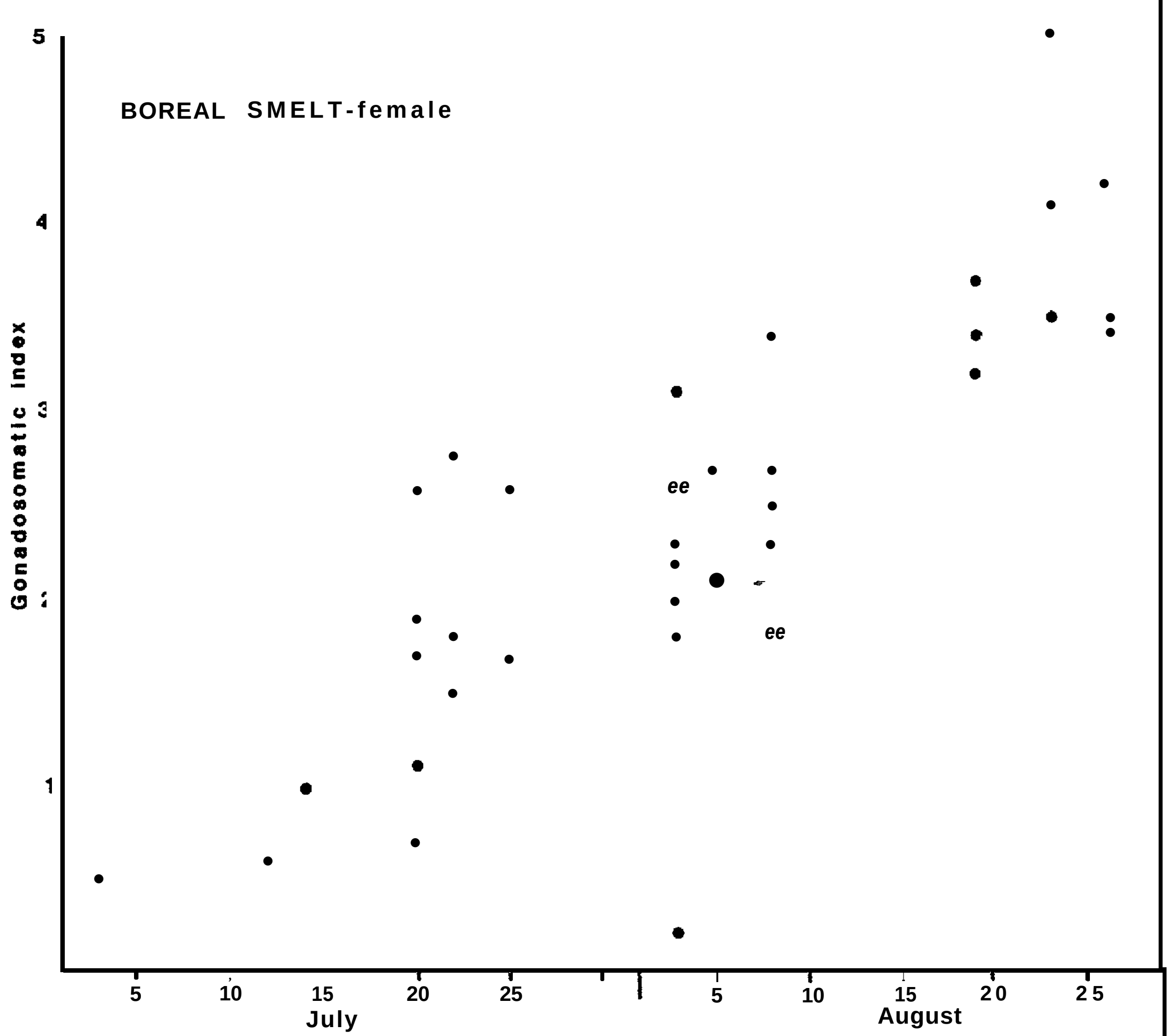


Figure 6-22. Gonadosomatic index (ovary weight/body weight) for female boreal smelt taken at Point Lay in 1983. Included are specimens reported by Schmidt and Craig (in press).

Table 6-5. Food items of boreal smelt (165-280 mm FL) taken by gill net at Point Lay from 22 July-26 August, 1983. Values are percent wet weight composition followed parenthetically by number of occurrences.

Food Item	Boreal Smelt N = 21	
Plant	● (5)	
Pebble	● (1)	
Unidentified	1 (3)	
Calanoid	* (1)	
Saduria entomon	● (1)	
Unidentified amphipod	● (1)	
Lysianassid	● (2)	
Onisimus glacialis	● (I)	
Onisimus littoralis	1 (3)	
Gammarus setosus	1 (6)	
Pontoporeia affinis	● (3)	
Oedicerotid	● (4)	
Total Amphipods		3 (11)
Mysis littoralis	30 (16)	
Mysis relicta	● (2)	
Neomysis sp.	● (1)	
Total Mydids		31 (16)
Unidentified fish	2 (2)	
Arctic cod	60 (6)	
Fish larvae	2 (2)	
Total Fish		65 (9)

● <1%*

Bering Strait to Bristol Bay. Spawning usually takes place in shallow coastal areas in late fall or winter (Morrow 1980).

During the 1983 Point Lay study, 1910 Arctic flounder were taken primarily by fyke net (94%). In terms of total catch they ranked fifth, accounting for 12% of all fish taken. Daily catch rates showed a trend similar to most other species with spikes occurring from 19-21 July and on 1 August during periods of sharp hydrographic transition (Fig. 6-23).

6.7.1 Size

Because of the tendency for Arctic flounder to congregate in shallow nearshore waters during summer, it was not surprising that only two individuals were caught as part of the Discoverer cruise. One 280 mm adult was taken by otter trawl at Station 27 (80 km off Ledyard Bay coast) and another 260 mm individual was taken at gill net Station 1 (0.8 km off Point Lay).

Arctic flounder taken by gill net ranged in size from 75-240 mm TL (Fig. 6-24). Length-frequency distributions of fyke-netted flounder taken at Point Lay revealed two primary size aggregates (Fig. 6-25). The smaller group ranged in size from 30-55 mm TL with a mode at about 45 mm. The remaining majority were part of an extremely broad based group covering the 85-240 mm size range. Length-frequency distributions for this larger group were monomodal at about 130-140 mm total. length during the 18 July-4 August period (747 fish) but size distribution was rather flat for the 19-31 August period (189 fish). All Arctic flounder comprising the smaller cohort were taken prior to 27 July with the exception of three individuals caught on 28 August.

6.7.2 Age and Growth

Although this species has been collected in the USSR (Andriyashev 1954), the Beaufort Sea (Griffithset al. 1975, Percy 1975, Jones and Den Beste 1978, Bond 1982. Griffiths 1983, Griffiths et al. 1983), the Bering Sea (Barton 1979), and various North American locations (Walters 1955), in most cases very few Arctic flounder have been examined in detail and so life history information for this species is fragmentary. Data analyses in the following discussions include specimens caught in this study as well as those collected by Schmidt and Craig (in press).

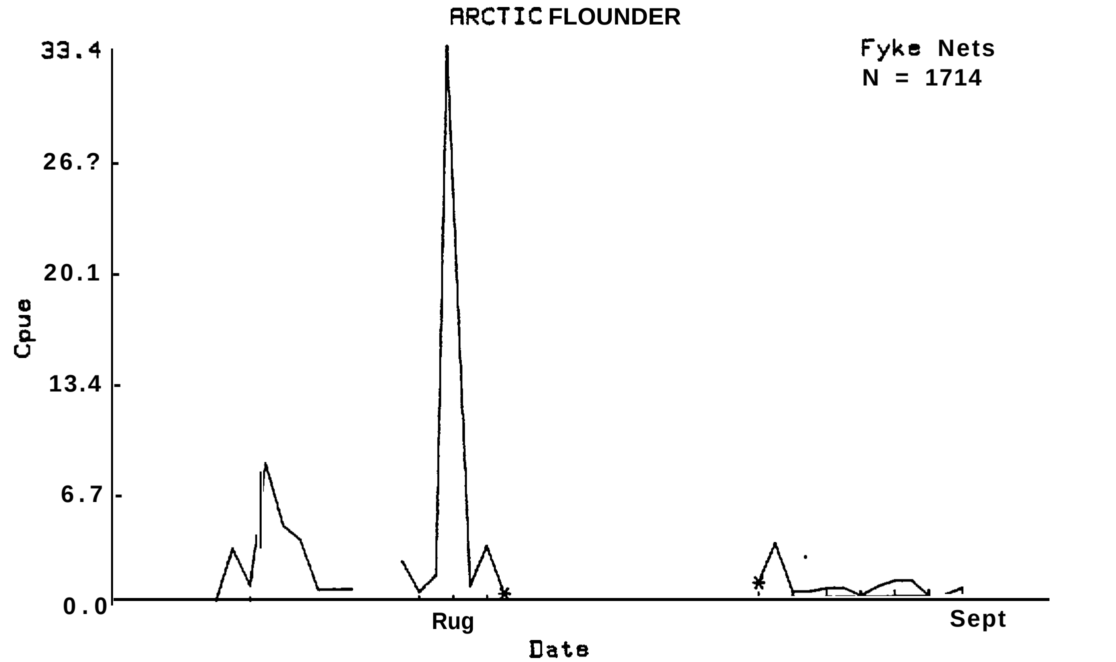


Figure 6-23. Daily catch rate (fish/h) of Arctic flounder taken by Point Lay fyke nets during July-August 1983.

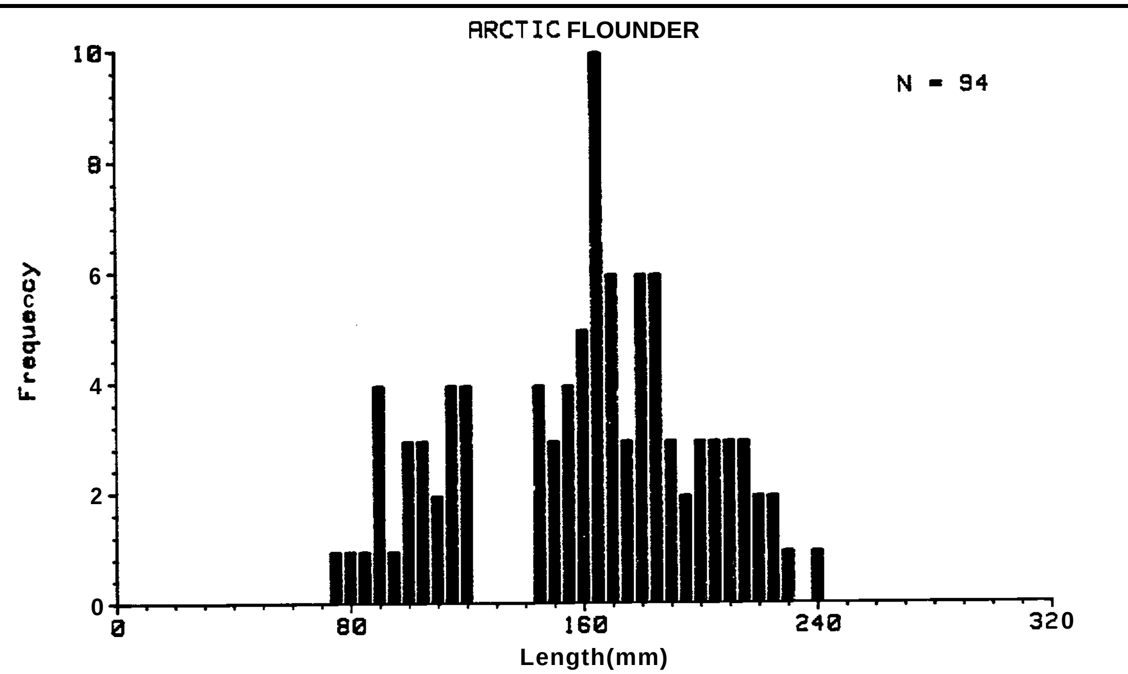


Figure 6-24. Length-frequency distribution of Arctic flounder taken by Point Lay gill nets during July-August 1983.

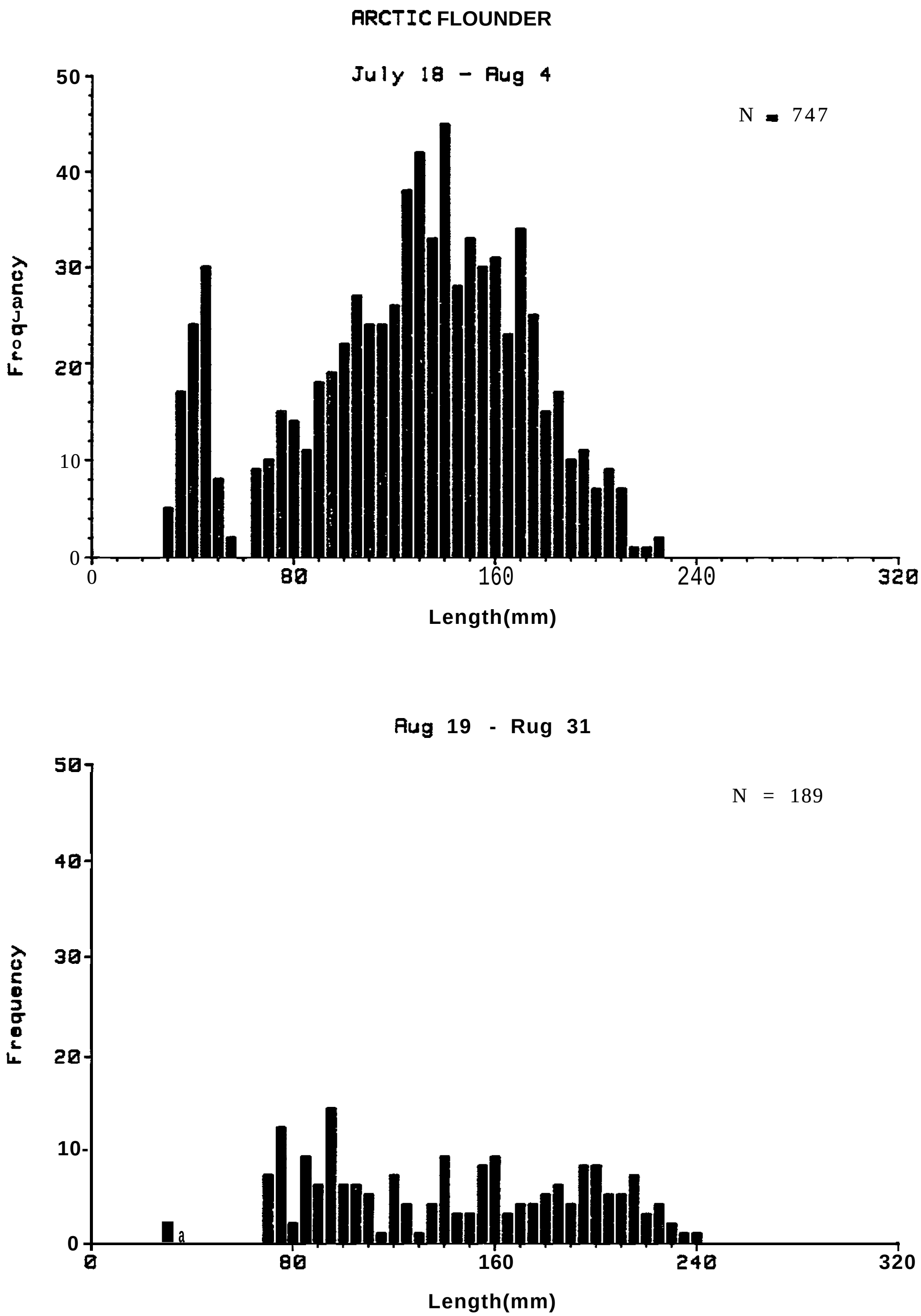


Figure 6-25. Length-frequency distributions of Arctic flounder taken by Point Lay fyke nets during July-August 1983.

The Point Lay sample ranged in age (otolith analysis) from young-of-the-year to Age 12 fish, but most Arctic flounders were o-6 years old (Table 6-6). Males and females differed in longevity and growth rate; females lived longer and were generally 2 cm larger than same-age males (Table 6-6, Fig. 6-26). This sexual dimorphism has been noted by others (Andriyashev 1954, Walters 1955).

The Arctic flounder is a slow growing species and the population at Point Lay grows more slowly than populations in the Barents or Beaufort seas (Fig. 6-27). Reasons for this relatively slow growth are not known.

6.7.3 Reproductive Status

Arctic flounder at Point Lay reach sexual maturity at Ages 4-6 (Table 6-7) which is similar to that recorded for this species in the Barents Sea (Andriyashev 1954). Size at maturity was 130-159 mm for males and 150-189 mm for females (Fig. 6-28).

Arctic flounder spawn in mid-winter at which time egg sizes are 1.0-1.5 mm (Andriyashev 1954). Morrow (1980) notes that mature fish spawn only once every two years. At the onset of our study in late June, the ovaries of mature females contained eggs measuring 0.3-0.8 mm and a few retained eggs (2.0-2.0 mm) from a previous spawning. Gonadosomatic indices (percent ovary weight/body weight) for these known spawners was 1.6-6.5% during the period 25 June-4 July 1983 (Fig. 6-29). By late summer (24 August-1 September), egg sizes had increased slightly to 0.5-1.0 mm and gonadosomatic indices of mature and maturing females were 7.2-14.6% (Fig. 6-29). Nine mature or maturing males caught in mid-summer (3 August) had gonadosomatic indices of 2.7-6.7%.

6.7.4 Food Habits

Of the 71 Arctic flounder stomachs examined, over 78% were empty. Those which had eaten, consumed polychaete and unidentified worms, the isopod Saduria entomon and the amphipod Onisimus littoralis. An interesting change in diet was noted when stomach content for the Arctic flounder gill-netted from late July-August was compared with that recorded for Arctic flounder taken from 4-20 July (Schmidt and Craig, in press). Major prey items during the first period were O. littoralis (39%), S. entomon (28%) and polychaetes. After 22 July, polychaetes and other worms

Table 6-6. Age and length relationships of arctic flounder at Point Lay, 1983. Ages were determined by otolith (break and burn technique.

	Females*					Males					% in** Population
		Total Length (mm)			%		Total Length (mm)			%	
Age	n	Mean	Range	SD	Mature	n	Mean	Range	SD	Mature	(n=1321)
0	5	43	(34- 48)	5.7	0						12
1	9	70	(54- 87)	11.4	0						15
2	2	91	(90- 91)	0*7	0						6
3	4	125	(109-138)	9.5	0	1	136	-	-	0	21
4	6	161	(139-187)	18.2	33	1	143	-	-	0	7
5	19	171	(154-195)	12.9	63	4	146	(144-148)	1.7	75	17
6	17	181	(152-200)	14.8	76	3	168	(158-177)	9.5	100	8
7	10	201	(188-210)	8.2	100	4	175	(170-179)	3.8	100	5
8	12	207	(190-219)	9.1	100	3	181	(178-186)	4.4	100	4
9	10	210	(165-229)	19.4	100	1	185	-	-	100	3
10	6	214	(206-223)	6.3	100						2
11	5	231	(220-246)	9.9	100						1
12	2	241	(238-243)	3.5	100						0.3
Totals	107					17					101.3

*Includes unsexed fish Ages 0-2.

*Based on a length stratified subsample of fish ages applied to the total catch (Ricker 1975).

Figure 6-26. Growth of Arctic flounder taken at Point Lay during summer 1983.

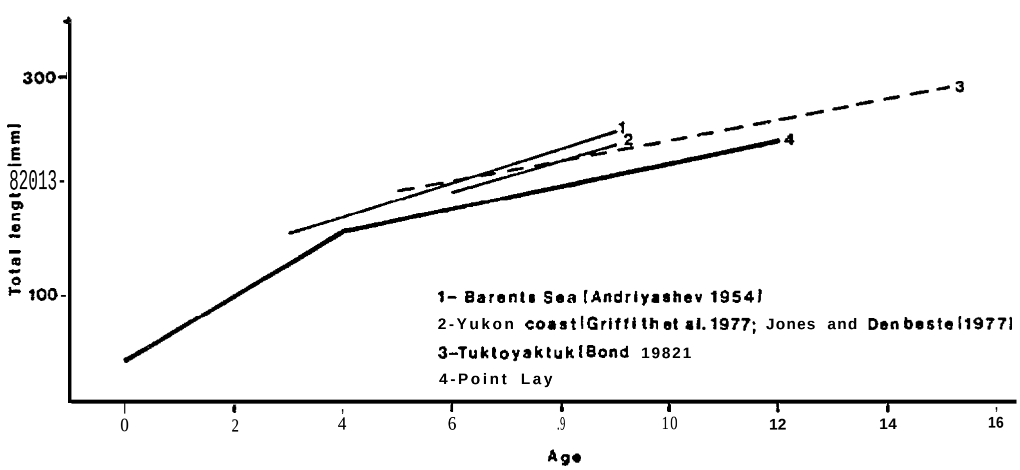


Figure 6-27. Growth patterns of Arctic flounder taken at Point Lay during summer 1983 and other areas.

Table 6-7. Food items of Arctic flounder taken by lagoon gill nets at Point Lay during summer 1983. Values are percent wet weight composition followed parenthetically by number of occurrences.

Food Item	4-20 July N=9[1] (170-230 mm TL)		22 July-29 August N=9 (165-225 mm TL)	
Plant	• (2)		3 (3)	
Pebble	* (2)		• (1)	
Unidentified	4 (8)			
Chironomid larvae	• (4)			
Polychaete (tube)	17 (7)		48 (9)	
Unidentified worm			35 (4)	
Saduria entomon	28 (8)		4 (5)	
Calanoid			* (1)	
Unidentified amphipod			* (1)	
Onisimus glacialis	39 (9)			
Onisimus littoralis	1 (1)			
Lysianassid	4 (6)		4 (3)	
Gammarus setosus	2 (6)		4 (1)	
Pontoporeia affinis	4 (9)		1 (3)	
Oedicerotid	* (2)		* (1)	
Total Amphipod		50 (9)		10 (5)
Unidentified mysid				
Mysis littoralis	• (1)		• (1)	
Mysis relicta	• (1)			
Total Mysids		* (2)		* (1)

[1]Including six specimens reported by Schmidt and Craig (in press).

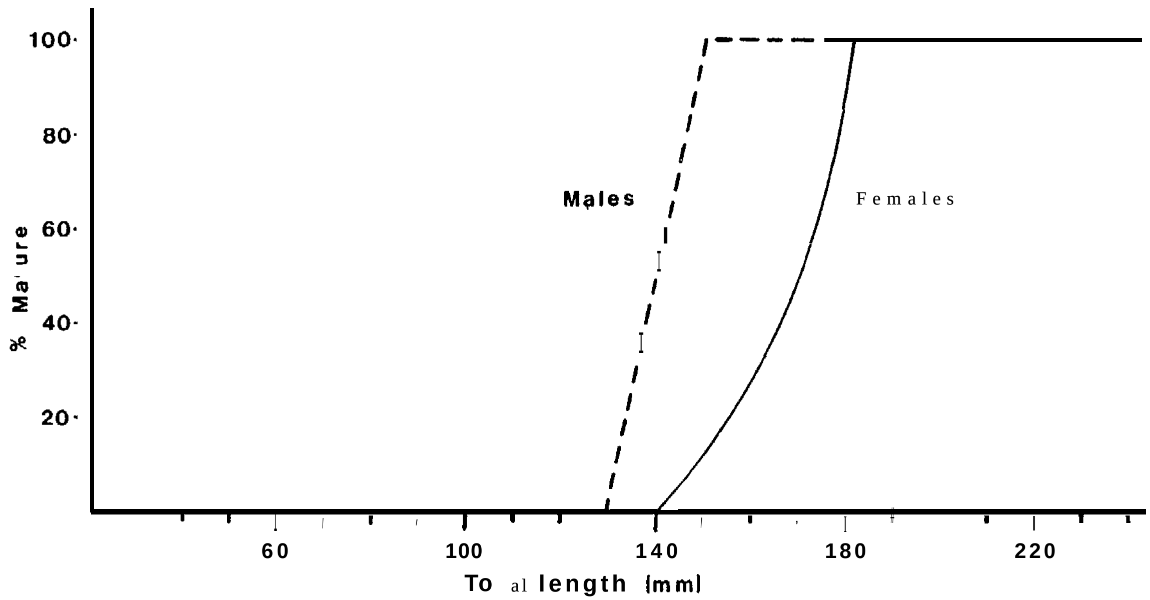


Figure 6-28. Size at maturity for Arctic flounder taken at Point Lay during summer 1983.

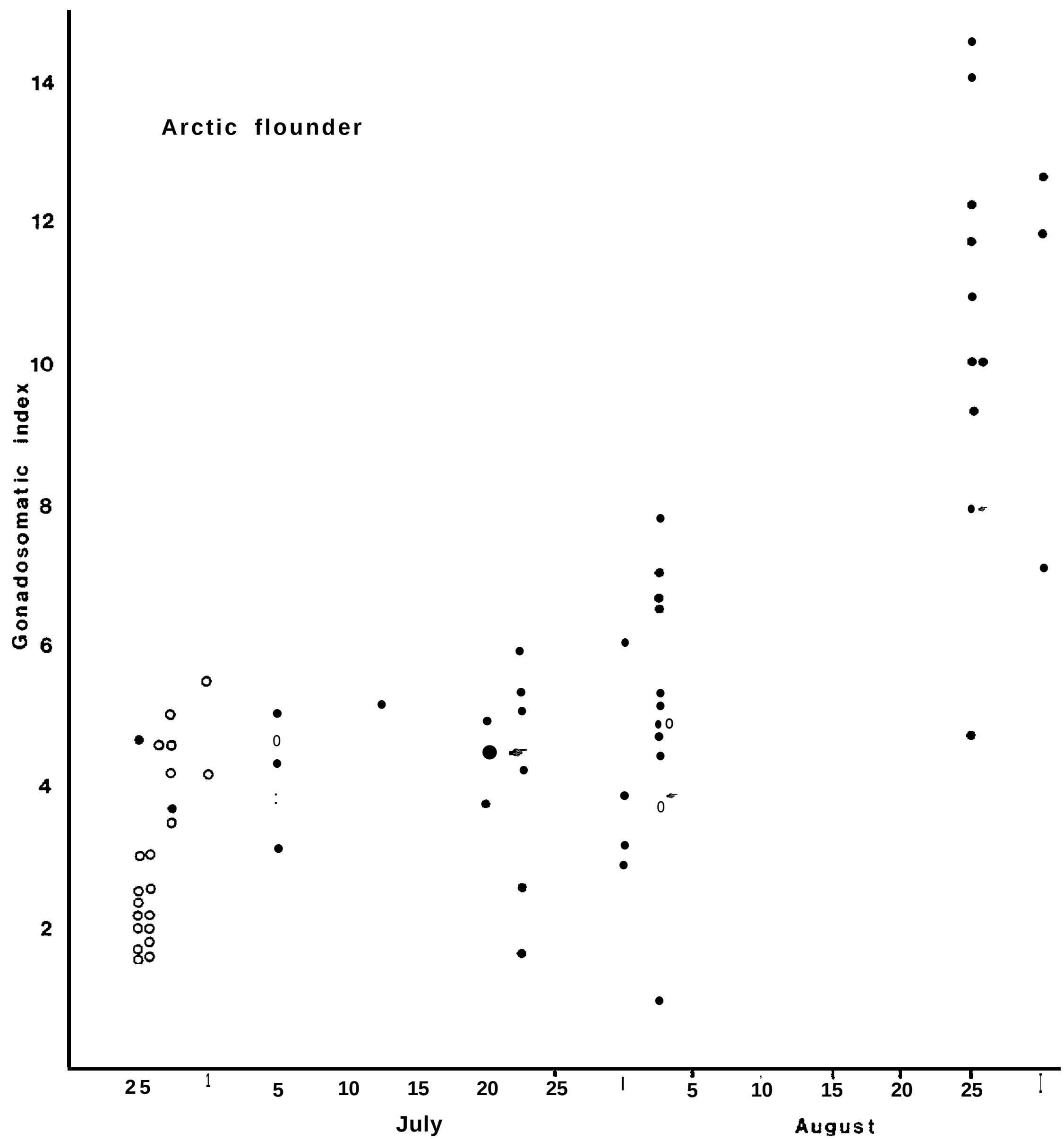


Figure 6-29. Gonadosomatic index (ovary weight/body weight) for female Arctic flounder judged to be mature (solid dots) and those with evidence of previous spawning (retained eggs) (open dots).

constituted 83% of Arctic flounder diet. These infauna were found to be a prey source in Beaufort Sea studies but not to this extent (Bendock 1977, Craig and Haldorson 1981).

Admittedly, sample sizes are small, however, such changes could result from fluctuations in overall prey density, changes in predator/prey size relationships or spatial discontinuity in prey distribution. In any event, these data illustrate the trophic adaptability in Arctic flounder.

6.8 Pink Salmon (Onchorhynchus gorbuscha)

Pink salmon are an anadromous species which spends its adult life at sea, then returns to natal streams to spawn. Their distribution covers coastal regions from southern California to the Canadian Beaufort Sea.

The 34 pink salmon caught during the Point Lay study were only a small portion (0.002%) of the total catch. No pink salmon were taken during the Discoverer cruise. Point Lay fish ranged in size from 385-5o5 mm FL. The length-weight regression was:

$$\text{Log Weight (g)} = -4.6 \text{ Log Length (mm)}, \; r^2=0.80, N=25$$
$$\text{or Ln Weight (g)} = -9.8 \text{ Ln Length (mm)}$$

6.8.1 Reproductive Status

Out of a subsample of 27 salmon, females (21) far outnumbered males (6). All fish were sexually mature and apparently positioned for a late summer spawning run. The gonadosomatic index (ovary weight/body weight) for females averaged 14.4% (range: 10-1-18.8, SD=2.1, N=19) and egg diameters averaged 5.2 mm (range: 4.7-5.7 mm, SD=0.3, N=20).

6.8.2 Feeding Habits

Half of the pink salmon examined had empty stomachs. The remaining 12 individuals had fed primarily on fish (74%), the amphipod Onisimis littoralis (12%) and Mysis littoralis (6%) (Table 6-8).

Table 6-8. Food items of pink salmon (422-505 mm FL) taken by gill net at Point Lay from 1-4 August, 1983. Values are percent wet weight composition followed parenthetically by number of occurrences.

Food Item	Pink Salmon N=12	
Plant	● (4)	
Pebble	* (2)	
Unidentified	5 (lo)	
Juvenile decapod	* (3)	
Euphausid	● (2)	
Unidentified amphipod	● (1)	
Onisimus littoralis	12 (6)	
Anonyx sp.	● (I)	
Gammarus setosus	1 (3)	
Gammaracanthus sp.	● (2)	
Atylus carinatus	● (2)	
Parathemisto abyssorum	● (l)	
Oedicerotid	* (1)	
Total Amphipods		13 (8)
Unidentified mysid	● (1)	
Mysis littoralis	6 (9)	
Mysis relicta	● (2)	
Neomysis sp.	● (1)	
Total Mysids		7 (10)
Fish larvae	16 (8)	
Fish egg	● (1)	
Arctic cod	58 (6)	
Unidentified flatfish	● (1)	
Total Fish		74 (10)

*<1%.

6.9 Arctic Staghorn Sculpin (Gymnocanthus tricuspis)

The Arctic staghorn sculpin is a demersal, marine fish with a circumpolar distribution. Tolerant of wide temperature and salinity fluctuations they are typically found in cold, marine waters at depths ranging from 0-240 mm (Andriyashev 1954).

This species numerically dominated otter trawl catches. Staghorns numbered 11,006 individuals and constituted 52% of all fish taken. They were present in24 of 25 (7-48 m depths) trawls but none were caught by Discoverer gill nets. No staghorn sculpin *were* taken in Kasegaluk Lagoon or adjacent shallow waters.

Staghorns ranged in size from 25-135 mm TL. The length-frequency distribution showed a primary mode at about 40 mm and a secondary mode at 70 mm (Fig. 6-30). Tentative data reported by Andriyashev (1954) would age the 40 and 70 mm size cohorts as 1+ and 2+, respectively. Length-frequency distributions did vary among stations but no discernible geographic pattern was evident.

6.10 Shorthorn Sculpin (Myoxocephalus scorpius)

The shorthorn sculpin is widespread in arctic waters and is found as far south as the Bering Sea *(Walters* 1955). Taxonomically, this species is characterized by great variability in meristic and morphological features and is represented by several geographically distinct races.

Shorthorn sculpin were the third most abundant species taken by otter trawl. Present in 23 of 25 tow samples, the 1723 specimens comprised 8% of total. catch. Fish ranged in total length from 30-215 mm. There was a notable absence of large fish (>65 mm) in all samples (Stations 1-18) collected northeast (inclusive) of the Point Lay transect--the distribution was monomodal at 40 mm and excluding one 115 mm specimen, ranged from 30-65 mm TL (Fig. 6-31). Cumulative length-frequencies for all samples taken southwest of the Point Lay transect (Stations 20-29) showed better representation of larger fish. The multimodal distribution contained distinct peaks at 40 and 70 mm. A 40 mm cohort would correspond with the 0+ age class in European representatives of this species (Bigelow and Schroeder 1953) and is probably the case with Chukchi specimens.

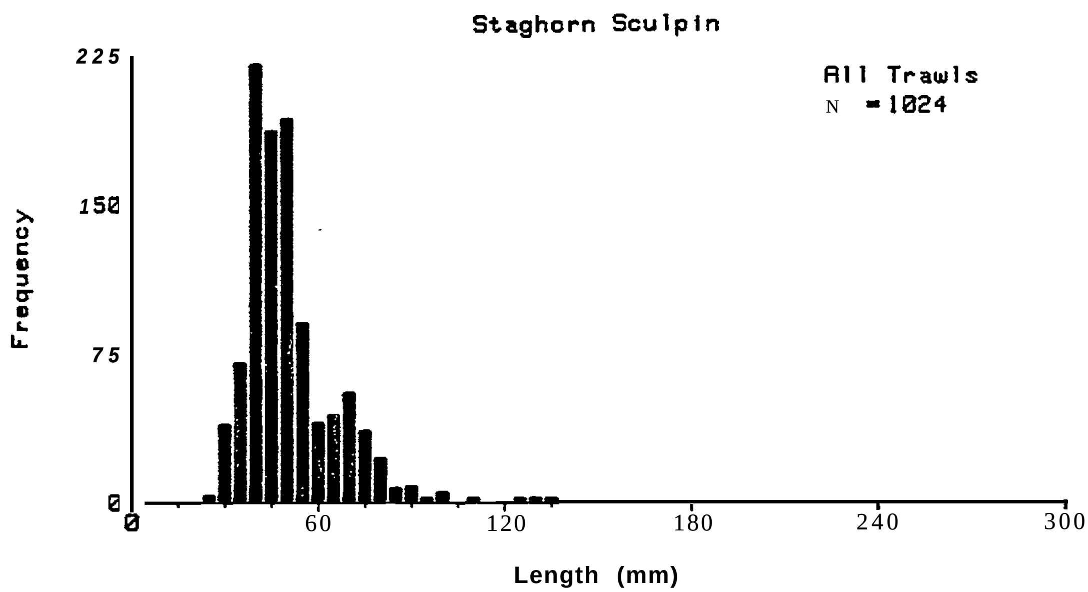


Figure 6-30. Length-frequency distribution of staghorn sculpin taken by otter trawl during the 25 August-13 September 1983 Discoverer cruise.

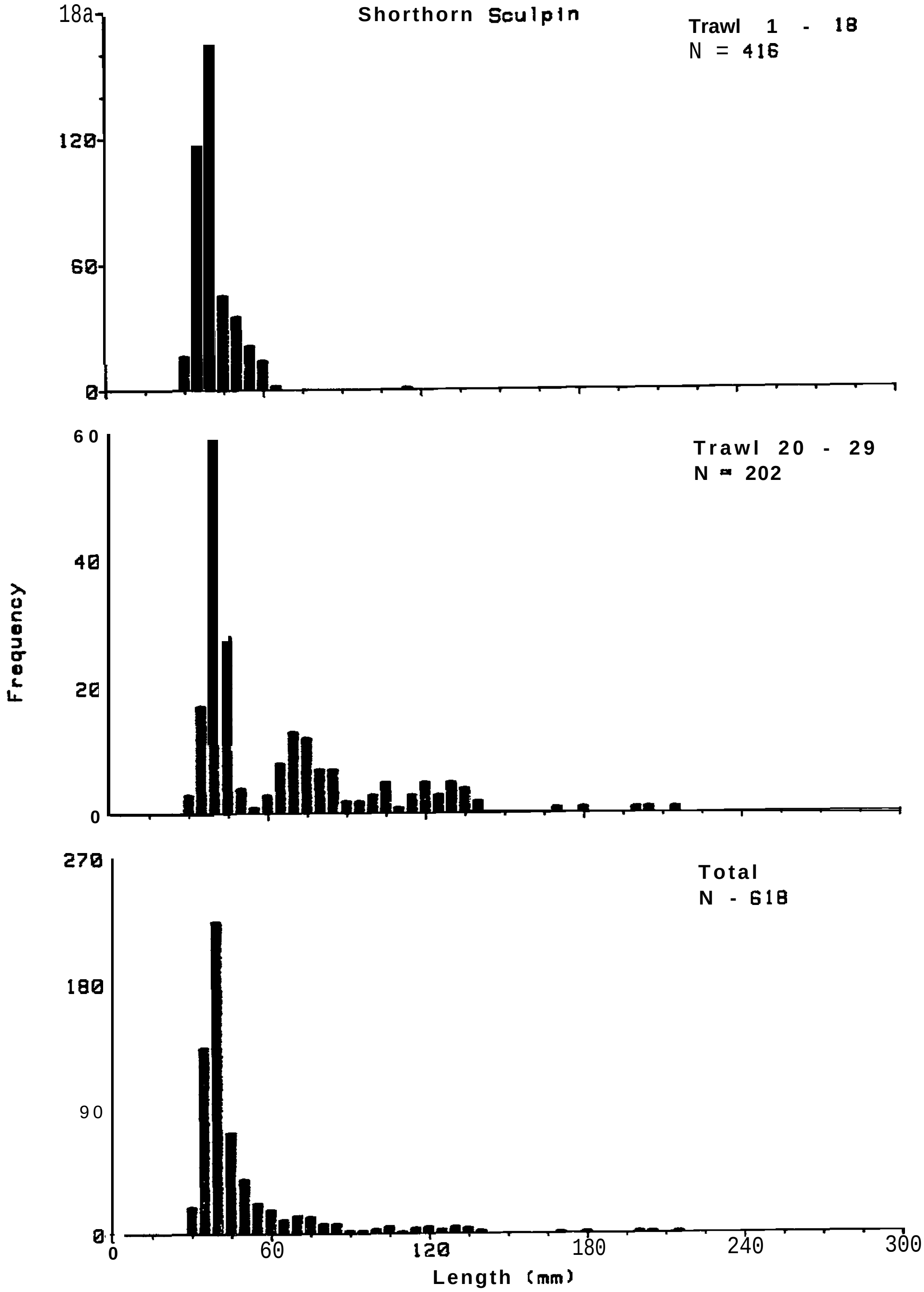


Figure 6-31. Length-frequency distributions of shorthorn sculpin taken by otter trawl during the 25 August-13 September 1983 Discoverer cruise.

Four additional shorthorns were taken by gill net--two (185 and 315 mm) at Station 7 (0.8 km off Wainwright) and two (140 mm each) at Station 11 (1 km off the Ledyard Bay coast). No specimens were taken during the Point Lay study.

Assuming that otter trawls sampled representatively, reasons for the virtual lack of large shorthorns in the northeast half of the study area are unclear. If spawning took place along the entire Chukchi coast one would expect to find a significant trace of older fish. Older representatives would also be expected if the specimens taken at Stations 1-18 were a separate race. Even if spawning was localized around Cape Lisburne and the northeasterly group were the result of pelagic fry dispersed by the Alaskan current, larger members should show up provided the species can survive their first winter. One alternative is that the observed presence of shorthorn sculpin northeast of Ledyard Bay reflects an anomaly in the distribution of pelagic fry caused by 1983 patterns in coastal current.

6.11 Hamecon (Artediellus scaber)

The hamecon is a marine cottid belonging to a genus commonly referred to as hookear sculpins. Morphometrically and meristically similar to its Atlantic counterpart, the Arctic hookear sculpin (A. uncinatus), the hamecon is found in coastal waters from the Kara to the Chukchi Sea as far south as the northern Bering Sea (Walters 1955).

A total of 832 hamecon were taken by otter trawl which ranked it fourth in adjusted deep water (>14 m, 25 ft trawl) catches and third in adjusted shallow water (<14 m, 12 ft trawl) catches. Specimens were collected at all depths (7-48 m). The cumulative length-frequency distribution was monomodal at 30 mm, strongly skewed and ranged from 20-80 mm TL. Length distribution varied among stations without a distinctive pattern. The one exception was Station 20 located 150 km northeast of Cape Lisbourne at which most of the larger specimens were taken (Fig. 6-32).

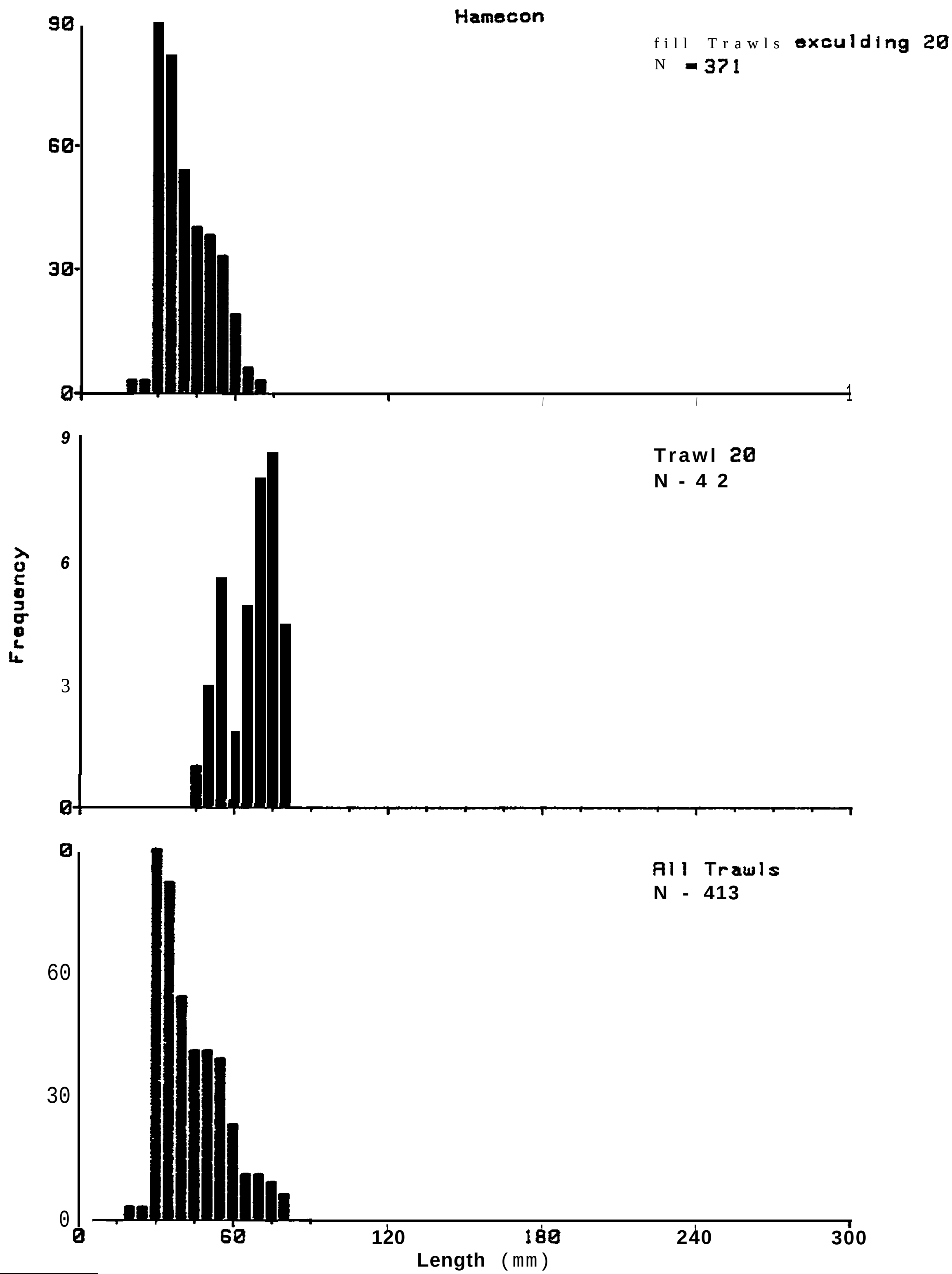


Figure 6-32. Length-frequency distributions of hamecon taken by otter trawl during the 25 August-13 September 1983 Discoverer cruise.

6.12 Other Sculpins

Five additional species of the family Cottidae were taken during the 1983 Chukdhi study--four occurred solely in otter trawl samples (ribbed sculpin, *Triglops pingeli*; antlered sculpin, *Enophrys diceratus*; eyeshade sculpin, *Nautichthys pribolovious*; spatulate sculpin, *Icelus spatula*), and the fifth was taken only at Point Lay (great sculpin, *Myoxocephalus polycanthocephalus*).

6.12.1 Ribbed Sculpin

The ribbed sculpin is circumpolar in distribution ranging south to the Bering Straits (Walters 1955). The 182 specimens taken by otter trawl ranged in size from 35-130 mm TL.

6.12.2 Great Sculpin

There is a possibility that this species may have been confused in the field with the morphometrically-similar *M. jaok*. The Bering Sea is the northern limit for *M. polyacanthocephalus* while *M. joak* is found in arctic Alaska (Wilimovsky 1956). Thirty specimens (80-185 mm TL) were taken at Point Lay.

6.12.3 Antlered Sculpin

Typically found south of the Bering Straits this species is a coastal water inhabitant (Andriyashev 1954). All 20 specimens were taken at Station 29 located 50 km southeast of Point Hope. They ranged in size from 50-110 mm FL.

6.12.4 Eyeshade Sculpin

The eyeshade sculpin is also typically encountered south of the Bering Straits but has been reported for the Chukchi Sea (Quast and Hall 1972). Andriyashev (1954) reported that this species serves as an indicator of warm water in the northern Bering Sea. Five individuals (30-50 mm TL) were taken at trawl Stations 7, 17 and 18.

6.12.5 Spatulate Sculpin

Spatulate sculpin are distributed in coastal waters from the Kara Sea eastward to Greenland and south to the Bering Sea (Walter 1955). A single individual (35 mm TL) was caught at trawl Station 18 near Wainwright.

6.13 Other Flatfishes

Three additional species of flatfish were collected as partof the 1983 Chukchi study: yellowfin sole (Limanda aspera), longhead dab (Limanda proboscidea) and Alaska plaice (Pleurenectes quadrituberculatus).

6.13.1 Yellowfin Sole

The yellowfin sole was the numerically dominant flatfish takenby otter trawl. The 44 specimens ranged in size from 35-115 mm FL. Twenty-five individuals were taken at Station 21.

6.13.2 Longhead Dab

A total of 14 longhead dab were collected during the 1983 Chukchi study; 12 (80-155 mm TL) at Point Lay and 2 (140 and 150 mm TL) at Discoverer gill net Station 1 located 0.8 km off Point Lay.

6.13.3 Alaska Plaice

A single Alaskan plaice (140 mm TL) was taken by Discoverer gill nets at Station 1.

6.14 Other Anadromous Fishes

Four additional anadromous species were collected at Point Lay: three Arctic char (Salvelinus alpinus - 180, 185 and 247 mm FL); two least cisco (Coregonus laurettae - 100 and 135 mm FL); two Bering cisco (Coregonus sardinella - 330 and 375 mm FL); and one chum salmon Oncorhynchus keta - 665 mm FL).

6.15 Sandlance (Ammodytes hexapterus)

The sandlance is a marine fish which leads a varied life. They are found in nearshore or offshore waters, sometimes in large schools, and may bury themselves in either nearshore or offshore sandy substrates. They range from southern California through the Beaufort Sea (Walters 1955).

A total of 38 sandlance were taken by otter trawl at Stations 1, 3, 7, 8, 12,21 and 28. They ranged in size from 85-160 mm FL. A single 95 mm individual was taken by fyke net at Point Lay. While this species ranked eighth in adjusted catch for deep water otter trawl stations, Quast (1972) found it to be one of the most abundant species during a 1970 sampling of the NE Chukchi Sea.

6.16 Walleye Pollock (Therayra chalcogramma)

The walleye pollock is a member of the cod family and generally ranges from the Bering Sea to central California (Hart 1973). The specimens taken by otter trawl during this study reflect the northern limits of this species range. Of the 28 individuals caught, 13 were taken at Station 29 (50 km SE of Point Hope), 10 at Station 28 (5 km off Cape Lisburne), 1 at Station 20 (100 km NW of Cape Lisburne) and 4 at Station 22 (20 km off the Ledyard Bay coast). Specimens ranged in size from 110-165 mm TL.

6.17 Snailfish (Liparis spp.)

Snailfish belong to a family (Cyclopteridae) of small northern fish, many of which have modified pelvic fins forming a ventral adhering disc presumably for attachment to rocks or other hard substrate. Their distribution is primarily neritic. Otter trawls collectd 50 individuals ranging from 50-90 mm TL.

6.18 Sturgeon Seapoacher (Agonus acipenserinus)

This bottom dwelling member of the family Agonidae is found in coastal waters from Oregon to Point Barrow (Walters 1955). Twenty-seven specimens were collected during the 1983 survey, three (45-65 mm TL) from Point Lay gill nets and 24 (35-90 mm TL) from otter trawl samples. All otter trawled specimens were collected in <22 m of water (Stations 1, 3, 8, 12.21 and 26).

6.19 Arctic Alligatorfish (Asedophoroides olriki)

A member of the poacher family, this demersal, marine species is found in arctic Alaskan waters as far south as the northern Bering Sea. All 15 specimens (45-70 mm TL) were taken by otter trawl at Stations 6, 7, 13. 20. 25 and 28.

6.20 Eelpouts

Six representatives of the demersal, marine family Zoarcidae were taken by otter trawl during the 1983 Chukchi cruise--the fish doctor (Gymnelis viridis), saddled eelpout (Lycodes mucosus), Arctic eelpout (Lycodes reticulatus), polar eelpout (Lycodes polaris), archer eelpout (Lycodes sagittarius) and Gymnelis hemifasciatus. Tentatively identified from McAllister et al. (1981), these species are pending taxonomic verification.

6.20.1 Fish Doctor

The fish doctor is a circumpolar, demersal species typically found in coastal waters less than 100 m in depth (Andriyashev 1954). The 37 specimens taken by otter trawl came from only five stations (6, 13, 18, 20 and 29) which covered depths of 20-47 m. Five individuals came from Station 29. Fish ranged in size from 55-120 mm TL.

6.20.2 Gymnelis hemifasciatus

Three specimens (80, 90 and 100 mm TL) of this rare species were caught at Station 6 located 32 km off Point Lay in 29 m of water.

6.2o.3 Saddled Eelpout

This species is known from the Bering and Chukchi seas and has been reported to occur in the Beaufort Sea (Frost and Lowry 1983). A single specimen (50 mm TL) was taken at Station 16 near Wainwright.

6.20.4 Arctic Eelpout

Five specimens (115-250 mm TL) were collected, threeat Station 20 and two at Station 27.

6.20.5 Polar Eelpout

Polar eelpout are distributed from the Kara Sea east to Greenland and as far south as the Bering Sea (Andriyashev 1954). All three specimens (85, 120 and 135 mm TL) were taken at Station 27 in Ledyard Bay.

6.20.6 Archer Eelpout

This species is considered to be a deep water inhabitant. The single 95 mm specimen was taken in 44 m of water at Station 27.

6.21 Pricklebacks

Otter trawls caught three species of the family Stichaeidae--fourline snakeblenny (Eumesogrammus praeciScus), slender eelblenny (Lumpenus fabricii), and Arctic shanny (Stichaeus punctatus).

6.21.1 Fourline Snakeblenny

The species is rare to arctic Alaskan waters. Frost and Lowry (1981) collected two specimens off Wainwright. Two specimens measuring 85 and 95 mm TL were taken 100 km NE of Cape Lisburne (Station 20) in 47 m of water.

6.21.2 Slender Eelblenny

Often considered circumpolar in distribution, the slender eelblenny ranges from the Beaufort to Bering seas (Walters 1955). With 538 specimens taken, this species ranked sixth in total abundance. Lengths ranged from 50-185 total length.

6.21.3 Arctic Shanny

This coastal, marine species is found from the western Beaufort Sea to the Bering Sea (Walters 1955). Eighteen specimens were taken by otter trawl-- 1 (95 mm TL) at Station 13, 3 (90, 95 and 120 mm TL)at Station28 and 14 (50-110 mm TL) at Station 29.

6.22 Whitespotted Greenling (*Hexogrammos stelleri*)

This species is known primarily from the North Pacific and Bering Sea. One specimen (70 mm TL) was collected at Station 21 and one (120 mm TL) at Station 29.

6.23 Threespine Sticklebacks (*Gasterosteus aculeatus*)

Pacific populations of threespine sticklebacks are typically found from Baja, California, to St. Lawrence Island (Morrow 1980); however, specimens have been reported from Simpson Lagoon (Craig and Haldorson 1981). A single 87 mm specimen was taken by Point Lay fyke net.

7.0 IMPACT VULNERABILITY AND GENERAL DISCUSSION

The main purpose of this study is to profile fishery processes in the NE Chukchi Sea and to determine their potential vulnerability to proposed oil and gas development associated with the 'Barrow Arch Sale No. 85". Of particular interest are fish species which constitute important trophic links in the overall food web or are important to regional subsistence fisheries. Such impact appraisals are, to a certain degree, limited in scope because of the lack of scientific information previously accrued for the Chukchi area. Nevertheless, certain characteristics of this system appear unique, particularly when gauged against fishery dynamics of the adjacent Beaufort and Bering seas.

The following section addresses the vulnerability of NE Chukchi Sea fish species to potential OCS impacts. The species covered are reported to be important subsistence and/or forage fish: ciscoes, whitefish, Arctic char, chum salmon, pink salmon, Arctic cod, saffron cod, capelin, fourhorn sculpin, sandlance and Pacific herring.

7.1 Effects of Development

Industrial activities associated with oil and gas development may impact the environment in several ways. The presence of drilling and support facilities such as man-made islands and causeways physically remove part of the marine environment that would otherwise be used by local fauna. These facilities may also act in modifying physical characteristics of temperature, salinity, turbidity, current and noise, thereby altering (either positively or negatively) the ecological usefulness of local environs. Other impact sources include toxic additions such as discharges generated as natural by-products of drilling activity and oil spills.

The severity of any such industrial impact is related to the timing and location of the perturbation. Mild, and at times seemingly innocuous descriptions such as changes in local hydrography and low level drilling discharges, may adversely affect a population if they persist for long periods of time. Severe but spatially limited impacts may be biologically amplified if they occur at critical locations such as spawning grounds, feeding areas or across major migratory pathways. Further potential damage to the stability of the biological system need not be direct but may manifest itself as a disruption of the trophic chain.

7.2 physical Environment

Temperature has repeatedly been demonstrated to be an important controlling factor in the biology of fishes. Nearly every facet of their physiological and biochemical character is thermally dependent. There are correlations between temperature and growth (Brett 1967, Brett et al. 1969, McCormick et al. 1972, Brett and Glass 1973, Shelbourne et al. 1973), the amount of food ingested (Kinne 1960, Brett and Higgs 1970), embryonic development and hatching success (Edsall 1970, Colby and Brooke 1973, Austin et al. 1975), resistance to infection (Amend 1970, Plumb 1973), and migratory behavior (McCleave 1978, Olla 1980). Further, laboratory studies have shown that fish will gravitate toward thermal levels which maximize physiological performance (Fry and Hart 1949, Fisher and Elson 1950. Brett 1971), scope for activity (Brett 1964, Beamish 1970) and growth potential (McCauley and Casselman 1980, Jobling 1981).

Although studied to a much lesser extent than temperature, salinity can affect a fishes metabolic rate, (Rao 1968, Hettler 1976), growth rate (Otwell and Merringer 1975, Hettler 1976) and hatching time (Kinne and Kinne 1962, Forrester and Alderdice 1966). Salinity can also modify thermal preferences (Kinne 1960, Garside et al. 1977, Fechhelm et al., in press).

From an ecological standpoint, OCS-induced alterations in temperature and salinity structure, as well as in other abiotic factors like turbidity and dissolved oxygen content, could jeopardize population success in a variety of ways. Potential damage would be greatest for species which depend upon the physical structure of a spatially limited environment (i.e., nearshore areas).

7.3 Anadromous Fish

7.3.1 Ciscoes, Whitefishes, Arctic Char, Chum Salmon

A notable finding of the 1983 investigation was the small number of anadromous fish taken in NE Chukchi waters. This contrasts sharply with Beaufort Sea studies in which Arctic cisco, Arctic char, least cisco, broad whitefish and humpback whitefish made up a conspicuous portion of survey catches (Craig and Haldorson 1981, Griffiths and Gallaway 1982, Griffiths et al. 1983). The presence of these species in the Beaufort Sea reflects that region's ability to successfully support anadromous fish stocks. Major freshwater drainages such as the Mackenzie, Colville, Sagavanirktok and other rivers act as spawning and overwintering grounds (Craig and McCart 1976). While specific patterns of river utilization and life history vary among species, arctic anadromous fish, in general, move into nearshore waters during the open-water season and disperse along the coastline to feed. River systems of the SE Chukchi Sea likewise supports major stocks of anadromous fish. Large populations of pink and chum salmon from the Noatak and Kivalina rivers (Geiger 1966, Smith et al. 1966), humpback whitefish (Alt 1978) and inconnu (Leibida 1970, Alt 1971) from the Kobuk River, and char from the Wulik and Kivalina rivers (Roguski and Winslow 1970, Alt 1978) enter coastal waters to feed and grow, and support extensive subsistence fisheries.

There are several reasons that could account for the low abundance of whitefish, cisco and char. First, rivers emptying into the NE Chukchi Sea may not be suitable for massive colonization. Second, coastal waters may not be productive enough to support large populations. Third, coastal waters may exhibit hydrological characteristics that impair their usefulness to anadromous species.

The effect of coastal hydrography has been an important issue in assessing fishery processes in the Beaufort Sea. Several studies have shown that the distribution of char, ciscoes and whitefishes is associated with a narrow band of relatively warm, brackish water which flows along the coast with prevailing currents (Craig and Haldorson 1981. Griffiths and Gallaway 1982, Griffiths et al. 1983). The width of this warm water band is usually 2-10 km depending upon coastal features such as barrier islands and freshwater plumes of large, North Slope rivers. Laboratory studies have shown that such hydrographic preference could be physiologically advantageous to the fish (Fry and Hart 1949; Brett 1964, 1971; Beamish 1970; Jobling 1981).

The situation in the Chukchi may differ considerably. Hachmeister (ASI, pers. comm.), conducting an OCSEAP-sponsored study of Chukchi Sea physical processes indicated that

> "...conditions for the nearshore regions from Point Lay to Key Cape and from Wainwright to Point Franklin will probably be to produce a more marine-like environment than those previously studied along the Beaufort Sea. In addition, the nearshore will also be subject to very large rapid changes in temperature and to some extent in salinity. This nearshore water will in turn be available for exchange with coastal lagoon systems in these areas which may also exhibit more marine-like physical properties."

'l'he SE Chukchi Sea may also be hydrologically more amenable to supporting anadromous fish stocks. With its water mass being more directly influenced by relatively warm marine waters flowing northward from the Bering Sea and the presence of large rivers discharging freshwater into Hope Basin and Kotebue Sound, the SE Chukchi Sea is warmer and less saline than waters north of Point Hope.

7.3.1.1 <u>Impact Vulnerability</u>. All of the ciscoes, char and chum salmon taken during this study were adults (>5 years old). Schmidt and Craig (in press) also did not catch young individuals during their 1983 summer season at Point Lay. This, coupled with the absence of previously collected data indicating the presence of major spawning stocks in NE Chukchi Sea rivers, could mean that the few ciscoes, char and chum salmon which are present are incidental migrators from either Beaufort Sea or SE Chukchi Sea stocks, This being the case, the main migratory pathways accessing the coastal waters of the NE Chukchi Sea would be in the vicinity of the Barrow and Lisburne peninsulas. While the seaward extent of these migratory pathways is unknown, any environmental disruption, particularly major incidents like an oil spill, would increase the probability of reduced migration to NE Chukchi waters from adjacent regions.

7.3.1.2 Subsistence Implications. Despite the aPParent low abundances, ciscoes, whitefish, char and chum salmon are caught in summer subsistence fisheries at the villages of Barrow, Wainwright, Point Lay and Point Hope (Ivie and Schneider 1979, petersenet al. 1979, Schneider and Bennett 1979, Craig and Schmidt 1982, Skvorc 1982). If the few specimens caught during the 1983 Point Lay summer survey are indicative of low anadromous fish density in the NE Chukchi Sea, then natural or man-made perturbations to recruitment could affect subsistence harvests.

7*3*1.3 Trophic Implications. Because of their low abundance, ciscoes, whitefish, char and chum salmon are probably insignificant components of the NE Chukchi Sea trophic web.

7.3.2 Pink Salmon

The presence of pink salmon in the Point Lay area was not unexpected since the existence of small spawning stocks in the Utukok, Kokolik and Kukpowruk rivers has been previously documented (Bendock 1979). The 26 specimens examined during this study were sexually mature and apparently positioned for a spawning run in late summer. The same was true of the pink salmon caught as part of the North Slope Borough Survey (Schmidt and *Craig,* in press). It is likely that the Kuk River system also serves as a spawning site for pink salmon.

7.3.2.1 Impact Vulnerability. Pink salmon are an anadromous fish with a two-year life-cycle. Spawning adults probably move upstream in late summer just prior to freeze-up. As a rule they do not go far upstream, however, spawning in rivers of the NE Chukchi Sea is probably correlated with the presence of relatively deep water holes, the bottoms of which remain ice-free throughout the winter season. Young-of-the-year most likely move into coastal waters during the late spring thaw--June tc early July. After spending about 21 months at sea, the adults return to spawn in their natal streams. Because of their life-cycle, runs of alternating years are genetically isolated. Each spawning river thus serves two distinct populations of salmon. Spawning migrations are generally dramatic since pink salmon tend to move into natal" streams in distinct pulses. The ocean distribution of pink salmon in the NE Chukchi Sea is unknown. Both nearshore and offshore waters may serve as feeding grounds.

The life-cycle characteristics of pink salmon are important in assessing their vulnerability to developmental impacts. Pulses of out-migrating young-of-the-year in early summer and returning adults in late summer may be expected to be intense and short-lived. It is at these times that the estuary waters surrounding the mouths of the Utukok, Kokolik, Kuk, Kukpowruk and other smaller rivers are critical to the success of individual stocks. In addition, if Chukchi pink salmon behave in a fashion similar to that of more southerly populations (Thorsteinson 1962. McInerney 1964), young-of-the-year will spend Part of their initial summer in and around estuarine waters.

Under a worst-cast scenario, catastrophic oil spills could severely damage pink salmon populations if they impact at these critical times and locations. In some cases rivers (Utukok, Kokolik and Kukpowruk), oil spill damage could be reduced by the presence of the Kasegaluk Lagoon barrier island chain. These barrier islands could offer partial protection from the intrusion of contaminated marine waters and enable fish to move along the coast in a lagoon corridor. Ocean access could be achieved by any of a dozen inlets along the 180 km long barrier island.

Because of the role that hydrographic factors play in reproduction, growth development and behavior, any plans for eventually constructing OCS support facilities in the Kasegaluk Lagoon/Point Lay vicinity should consider repercussions to local water quality.

7.3.2.2 Subsistence Implications. As was the case with ciscoes, whitefish and char, pink salmon are taken by coastal subsistence fisheries (Ivie and Schneider 1979, Petersen et al. 1979, Schneider and Bennett 1979, Craig and Schmidt 1982). A reduction in subsistence catch would be expected to vary in proportion to any impact to rivers supporting salmon populations.

7.3.2.3 Trophic Implications. Young fry probably serve as a food source for other fish during their initial summer, however, since local stocks are relatively small, this species is probably not a major link in the NE Chukchi Sea food web.

7.3.3 Boreal Smelt

Boreal smelt enter Chukchi River systems to spawn as soon as breakup permits. While upstream migrations of 100 km or more have been observed (Berg 1948), the run typically covers a short upstream distance. Spawning may even occur in brackish waters behind barrier beaches or in tidal zones (Bigelow and Schroeder 1963, McKenzie 1964). Hatching occurs in 10-29 days depending on temperature (Morrow 1980). Young fry are carried downstream to the estuary where they may spend their initial summer.

7.3.3.1 Impact Vulnerability. The vulnerability of Chukchi stocks of boreal smelt are essentially similar to that previously described for pink salmon, with estuaries being the critical location and the open water summer period being the critical time.

Modifications in the hydrographic characteristics of nearshore areas by OCS development could pose an additional hazard to boreal smelt, depending upon their reproductive strategy. Spawning in brackish areas would increase egg exposure to changes in temperature and salinity regimes caused by man-made structures. Temperature is an important determinant of hatching time and excessive salinity can kill eggs (Bigelow and Schroeder 1963). The presence of petroleum contaminants would further increase the probability of damage to the overall stock.

7.3.3.2 Subsistence Implications. Boreal smelt is an important subsistence fish, particularly at Wainwright during winter (Ivie and Schneider 1979, Schneider and Bennett 1979, Craig and Schmidt 1982). Since boreal smelt do not undergo extensive migrations (Morrow 1980), the Wainwright subsistence fishery and the Kuk River stock are closely tied entities. Damage to this population would most certainly be felt by the village of Wainwright.

7.3*3*3 Trophic Implications. While fry contribute to the trophic 'soup" in estuaries during summer, this species by itself does not appear to constitute a major component in the Chukchi food chain.

7.4 Marine Fish

7.4.1 Capelin

The fact that capelin spawn in nearshore waters make this area critical to the population's success. Our data indicate that the seaward side of the barrier islands at Kasegaluk Lagoon serves as a spawning site; however, other portions of the Chukchi coastline may also be used for this purpose.

Physical requirements for spawning and hatching are unknown but seem to vary among geographic populations. In southern British Columbia, capelin spawn in 10-12°C waters. Spawning of the Atlantic population takes place at 2-3°C (Hart 1973). If spawning and early development in Chukchi populations are governed by strict temperature and salinity dependencies, then changes in hydrographic conditions created by the presence of nearshore OCS facilities (i.e., causeways) could affect the population. Oil spills which reach landfall would also have a detrimental affect on eggs and fry. Under worst-case scenarios, the net affect on the population would depend on the spatial limits of the impact and the range of coastline used for spawning.

7.4.1.1 Subsistence Implications. Capelin are not subsistence harvested along the NE Chukchi coast.

7.4.1.2 Trophic Implications. Young-of-the-year capelin are undoubtedly eaten by fish in nearshore areas during summer. Adults may be eaten by seals and birds and have been listed as an important item in the summer diet of belukha whales (Seaman and Burns 1980).

7.4.2 Arctic Cod

The Arctic cod is one of the most widely distributed and abundant of the marine fishes and measurable adverse impacts to Arctic cod are unlikely because (a) oil under ice has reduced dispersion and volubility and (b) the pelagic eggs would be widely dispersed. However, Arctic cod eggs are buoyant and thus susceptible to light density hydrocarbons in the event of a winter oilspill. Spawning may take place in nearshore areas during winter (Craig et al. 1982). Cod are often associated with the underside of sea ice and open ice fissures (Sekerak 1982), also consolidation areas for light density contaminants.

7.4.2.1 Subsistence Implications. Cod are taken incidentally but generally do not constitute a primary target species for subsistence fisheries.

7.4.2.2 Trophic Implications. The trophic importance of Arctic cod was summarized by Sekerak (1982):

> '(Arctic cod) are important because they figure prominently in the diet of many highly prized marine mammals and seabirds. Recent studies on the feeding ecology of vertebrates have confirmed that the Arctic cod is eaten by white whales, narwhals, ringed seals, bearded seals, harp seals, walruses (occasionally), thick-billed and common murres, black guillemots, black-legged kittiwakes, northern fulmars, Arctic terns, and glaucous, Sabine's, ivory and Ross' gulls (Quast 1974; Bradstreet, 1976, 1977, 1979, 1982; Divoky 1976, 1978; Lowry et al. 1978; Springer and Roseneau 1978; Davis et al. 1980; Bradstreet and Cross 1982). In many cases, the Arctic cod forms a significant fraction of the food consumed by the above marine mammals and seabirds. Arctic cod are also of indirect importance to polar bears and Arctic foxes, since their principal marine food, the ringed seal, also relies on Arctic cod as food. The importance of Arctic cod in arctic trophic relationships is underscored, since no alternate food source of equivalent value appears to exist."

7.4.3 Fourhorn Sculpin

Fourhorn sculpin are typically associated with nearshore waters throughout their life. Spawning takes place in winter when adhesive eggs are extruded onto the substrate. Hatching may take up to three months depending on temperature (Morrow 1980). Shortly after breakup both adults and fry move enmass into shallow coastal waters where they feed during summer (Andriyashev 1954, Westin 1970).

7*4*3*1 Impact Vulnerability. Nearshore areas are critical habitats for fourhorn sculpin. The presence of toxic contaminants during winter could increase egg mortality. Sculpin eggs are sensitive under normal circumstances and require parental care during incubation (Morrow 1980).

As with capelin, one advantage that fourhorn sculpin may hold over many of the anadromous species is a broad coastal distribution of critical habitat. Even though the nearshore habitat is important, large stretches of coastline between Point Hope and Point Barrow are probably used. This being the case, localized environmental descriptions would have a low probability of affecting the overall population.

7.4.3.2 Subsistence Implications. Fourhorn sculpin are not utilized in subsistence fisheries. Craig and Schmidt (1982) reported that sculpin gill netted by local villagers at Wainwright were discarded. They also found that some Point Lay fishermen prefer ocean fishing because of the lower occurrence of fourhorn sculpin than occurs in Kasegaluk Lagoon.

7*4*3.3 Trophic Implications. Sculpin serve as a food source for birds and marine mammals (Swartz 1966; Springer and Roseneau 1978, 1979; Lowry et al. 1979; Seaman and Burns 1980). From this standpoint localized disruptions in sculpin populations could deprive consumers of a forage species. This is particularly true of the large bird populations that inhabit the Cape Lisburne area.

7.4.4 Saffron Cod

The reproductive strategy of saffron cod is similar to that of fourhorn sculpin in that they spawn in nearshore areas during winter, presumably by extruding adhesive eggs onto the substrate (Morrow 1980), thus making eggs vulnerable to high density pollutant exposure; however, a broad coastal distribution could act as a buffer against localized impacts.

7.4.4.1 Subsistence Implications. Like Arctic cod, saffron cod are taken occasionally, often as part of winter "tomcod" taken by jig line.

7.4.4.2 Trophic Implications. Saffron cod serve as an important food item for marine mammals (Frost and Lowry 1981, Lowry et al. 1980, Seaman and Burns 1980).

7.4.5 Sandlance

Sandlance spawn in shallow coastal areas but may otherwise inhabit either nearshore or offshore waters (Hart 1973). Data collected during the present study gave no indication of the time or location of spawning.

The sandlance is important to the Chukchi region because it is a principle food item of Cape Lisburne and Cape Thompson bird colonies (Springer and Roseneau 1978, 1979). Springer and Roseneau (1979) considered it to be a critical trophic component in the success of kittiwake populations:

> "One of the most critical elements of kittiwake biology in the region appears to be sandlance. In certain years the fish school in dense shoals in shallow, nearshore waters and are easy prey for most seabirds, especially kittiwakes which are restricted to feeding in waters less than about one meter in depth. Sandlance have been seen to fluctuate in their abundance and in the time when they arrive near the bird colonies, fluctuations which have coincided with major changes in kittiwake reproductive success."

Because of this predator/prey relationship, nearshore areas around the Lisbourne Peninsula should be considered a vulnerable area. Localized impacts to the sandlance population would, with time, be mitigated by recruitment and recolonization by more southerly stocks, however, bird populations could be severely affected during the interim.

7.4.6' Pacific Herring

Pacific herring are most vulnerable to OCS impacts during spawning periods. Adhesive demersal eggs located in shallow, nearshore areas would be exposed to high specific gravity contaminants. If Chukchi herring do spend their initial summer in nearshore habitats, modified hydrography caused by man-made structures could affect initial growth rates.

The most important subsistence use of herring occurs in the SE Chukchi Sea. Barton (1977) reported herring to be an important element at the village of Shishmaref but less vital to the subsistence of villages at Point Hope, Buchland and Deering. Herring are taken incidentally at Point Lay (Schmidt, LGL pers. comm.).

8.0 SUMMARY AND CONCLUSIONS

The most prominent species encountered during the 1983 Chukchi study were Arctic cod, Arctic staghorn sculpin, fourhorn sculpin, capelin, shorthorn sculpin, hamecon, Arctic flounder and saffron cod. Fourhorn sculpin and Arctic flounder are distributed nearshore (<1 km) while the remaining cottids were found exclusively in deeper, offshore (>1 km) waters. Arctic cod and saffron cod occupied both habitats.

Ciscoes, whitefish, Arctic char and chum salmon were much less abundant in the NE Chukchi Sea than in the adjacent Beaufort and SE Chukchi seas. The available evidence suggests that streams along the NE Chukchi coast support very small runs, if any, of these species. This being the case, then the few specimens which are present may be incidental migrants from Beaufort and SE Chukchi populations. Oil spill impacts to coastal regions around Barrow or the Lisburne peninsulas could impede migration/recruitment and in turn reduce subsistence catches.

Pink salmon and boreal smelt appear to be the two primary anadromous fishes of Chukchi Sea coastal waters. Large river systems like the Kokolik, Utukok, Kukpowruk and Kuk serve as spawning grounds for both species. The estuaries of these spawning rivers are important to reproduction and population success. Spawning runs of boreal smelt in spring and pink salmon in late summer could be impeded by the presence of petroleum contaminants. Estuaries are used by the fry of both species during their initial summer. Chemical contamination at this time could result in increased mortality of young-of-year. Alterations in the nearshore physical environment (i.e., temperature, salinity) caused by the presence of OCS support facilities could further affect early stagesof growth and development. Any population damage would be felt in the subsistence fishing of either species. This is particularly true of the Kuk River smelt population which supports an important winter fishery at Wainwright.

Arctic cod are one of the most important forage fishes supporting marine mammals and bird populations. Because of its high abundance and wide distribution in arctic seas this species is, overall, best suited to withstand OCS impacts. From a more localized standpoint, however, Arctic cod are vulnerable to developmental-induced chemical contaminants. Low specific gravity pollutants could destroy buoyant eggs which are released in nearshore areas during winter spawning. The tendency for cod to congregate just beneath ice layers and around open water fissures during winter likewise renders them vulnerable to light density petroleum discharges.

Saffron cod, fourhorn sculpin, sandlance, Pacific herring and capelin all serve as food sources for higher vertebrate consumers. Saffron cod, and to a lesser extent Pacific herring, are also taken by susbistence fisheries.

One common thread of vulnerability shared by all of these species is their reproductive strategy. All spawn in shallow, coastal waters by extruding adhesive eggs on the substrate or local vegetation--saffron cod and fourhorn sculpin during winter and sandlance, capelin and herring in summer. Demersal eggs could be destroyed by the presence of high density petroleum contaminants. Further, the value of shallow, nearshore waters as feeding grounds and nursery areas could also be curtailed by contamination or through modifications in temperature and salinity regimes which might result from the construction of support facilities (i.e., causeways). Hydrographically-induced changes in early growth and development could, in the long run, adversely affect population strength.

One factor which could mitigate damage to NE Chukchi Sea populations centers on the spatial extent to which these species make use of coastal habitats. The greater the area of exploitable habitat the lower the probability that a spatially finite impact would severely affect the population. There is not enough information to determine the extent and homogeneity of coastal distribution in the NE Chukchi Sea for these species.

Even though localized impacts may not result in long-term damage to the success of the general fish population, they could have more serious trophic repercussions to higher consumers. A prime example is the apparent trophic dependency that seabird colonies of Cape Lisburne have for sandlance and sculpin. Even a short-term reduction in the nearshore abundances of these fish could seriously affect these bird colonies, particularly during rearing of young.

As might be expected, the dominant marine and anadromous fish species of the Northeast Chukchi Sea are most vulnerable to OCS impacts which occur in shallow nearshore areas. This coastal edge is, to one degree or another, used for spawning, feeding and migration.

The environmental stability of this area should be considered if 'Barrow Arch Sale No. 85" results in the discovery of commercially exploitable petroleum reserves.

9.0 LITERATURE CITED

Alt, K. 1971. A life history study of sheefish and whitefish in Alaska. Alaska Dep. Fish and Game. 12:1-31.

Alt. K. 1978. Inventory and cataloging of sport fish and sport fish waters of western Alaska - Wulik-Kivalina rivers study. Annu. Rep., Alaska Dep. Fish and Game. 19:61-76.

Alverson, D.L. and N.J. Wilimovsky. 1966. Fishery investigations of the southeastern Chukchi Sea. Vol. 2, Chap. 31, Pages 843-860. In: N.J. Wilimovsky and J.N. Wolfe (eds.). Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Commission, U.S. Dep. Commerce, Springfield, VA.

Amend, D.F. 1970. Control of infectious hematopoietic necrosis virus disease by elevating the water temperature. J. Fish. Res. Board Can. 27:265-27o.

Andriyashev, A.P. 1954. Fishes of the northern seas of the U.S.S.R. Izdatel'stvo. Akad. Nauk. SSSR, Moskva-Leningrad. Translation from Russian, Israel Program for Scientific Translations. Jerusalem, 1964. 617 p.

Austin, H.M., A.D. Sosnow and C.R. Hickey, Jr. 1975. The effects of temperature on the development and survival of eggs and larvae of the Atlantic silverside, Menidia menidia. Trans. Amer. Fish. Sot. (1):762-765.

Barton. L. 1979. Finfish resource surveys in Norton Sound and Kotzebue Sound. In: Environ. Assess. Alaskan Cont. Shelf, Final Rep., Prin. Invest., NOAA/OCSEAP, Boulder, CO. 4:75-313.

Beamish. F.W.H. 1970. Oxygen consumption of largemouth bass, Micropterus salmoides, in relation to swimming speed and temperature. Can. J. Zool. 48:1221-1228.

Bendock, T. 1977. Beaufort Sea estuarine fishery study. Res. Unit 233. Pages 670-729. In: Envir. Assess. Alaskan Cont. Shelf., Final Rep. Prin. Invest. Vol. 4, March 1979. BLM/NOAA, OCSEAP, Boulder, CO.

Bendock, T. and J. Burr. 1980. Index to North Slope stream and lake surveys. Rep. by Alaska Dep. Fish and Game (Fairbanks). 11 p.

Bendock T.N. 1979. Inventory and cataloging of arctic area waters. Alaska Dep. Fish and Game, Sport Fish Division. Annual Performance Rep., Study No. G-I. 20:1-64.

Berg, L.S. 1948. Freshwater fishes of the U.S.S.R. and adjacent countries. Guide to the fauna of the U.S.S.R. No. 27. Vol. 1, 4th ed. Akad. Nauk SSSR Zool. Inst., Moscow. Translated from Russian by Israel Program for Scientific Translations, 1962. Office of Technical Services, U.S. Dept. Commerce, Washington, D.C. 504 p.

Bigelow, H.B. and W.C. Schroeder. 1953* Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53(74). 577 P.

Bigelow, H.B. and W.C. Schroeder. 1963. Family Osmeridae. Fishes of the Western North Atlantic. Sears Found. Mar. Res., Mere. 1(3):553-597.

Boesch, D.F. 1977. Application of numerical classification in ecological investigations of water pollution. Spec. Report 77, Vir. Instit. of Marine Science. 115 p.

Bond, W. 1982 A study of the fishery resources of Tuktoyaktuk Harbour, southern Beaufort Sea coast, with special reference to life histories of anadromous coregonids. Can. Tech. Rep., Fish and Aquat. Sci. No. 1119. 90 p.

Bowden, C. and L. Moulton. 1981. Resource report for the proposed Hope Basin OCS oil and gas lease sale #86. Rep. by Alaska Dep. Fish and Game, Marine/coastal Habitat Management. Anchorage, AK. 121 P.

Bradstreet. M.S.W. 1976. Summer feeding ecology of seabirds in eastern Lancaster Sound, 1976. Unpublished rep. by LGL Limited for Norlands Petroleum Ltd. 187 p.

Bradstreet, M.S.W. 1977. Feeding ecology of seabirds along fast-ice edges in Wellington Channel and Resolute Passage, N.W.T. Unpubl. rep. by LGL Limited for Polar Gas Project. 149 p.

Bradstreet, M.S.W. 1979. Feeding ecology of seabirds in Northwest Baffin Bay, 1978. Unpubl. rep. by LGL Limited for Petroleum Canada. 65 p.

Bradstreet, M.S.W. 1982. Occurrence, habitat use, and behavior of seabirds, marine mammals. and arctic cod at the Pond Inlet ice edge. Arctic 35:28-40.

Bradstreet, M.S.W. and W.E. Cross. 1982. Trophic relationships at High Arctic ice edges. Arctic 35:1-12.

Brett. J.R. 1964. The respiratory metabolism and swimming performance of young sockeye salmon. J. Fish. Res. Board Can. 21:1183-1226.

Brett, J-R. 1971. Energetic responses of salmon to temperature. A study of some thermal relations in the physiology and freshwater ecology of sockeye salmon (Oncorhynchus nerka). Am. Zool. 11:99-113.

Brett, J.R. 1967. Swimming performance of sockeye salmon, Onchorhynchus nerka, in relation to fatigue time and temperature. J. Fish. Res. Board Can. 24:1731-1741.

Brett, J.R. and D.A. Higgs. 19'70. Effect of temperature on the rate of gastric digestion in fingerling sockeye salmon, Oncorhynchus nerka. J. Fish. Res. Board Can. 27:1767-1779-

Brett, J.R. and N.R. Glass. 1973. Metabolic rates and critical swimming speeds of sockeye salmon (Oncorhynchus nerka) in relation to size and temperature. J. Fish. Res. Board Can. 30:379-387.

Brett, J. R., J.E. Shelbourn and C.T. Shoop. 1969. Growth rate and body composition of fingerling sockeye salmon, Oncorhynchus nerka, in relation to temperature and ration size. J. Fish. Res. Board Can. 26:2363-2394.

Coachman, L.K. and K. Aagaard. 1981. Reevaluation of water transport in the vicinity of Bering Strait. Pages 95-110. In: D.W. Hood and J.A. Caulder (eds.). Eastern Bering Sea Shelf Oceanography and Resources. USDC Office of Marine Pollution Assessment, Washington. D.C.

Cohen, D.M. 1954. Age and growth studies on two species of whitefishes from Pt. Barrow, Alaska. Nat. Hist. Mus., Stanford Univ., Stanford Ichthyological Bull. Vol. 4(3):168-187.

Colby, P.J. and L.T. Brooke. 1973. Effects of temperature on embryonic development of lake herring. J. Fish. Res. Board Can. 30:799-810.

Craig, P.C. and P. McCart. 1976. Fish use of nearshore coastal waters in the western arctic: emphasis on anadromous species. Chap. 23, Pages 361-388. In: Hood, D.W. and D.C. Burrell (eds.). Assessment of the arctic marine environment: Selected topics. Occas. Publ. No. 4, Inst. Mar. Sci., Univ. Alaska, Fairbanks.

Craig, P.C. and W.B. Griffiths. 1981. Studies of fish and epibenthic invertebrates in coastal waters of the Alaskan Beaufort Sea. Annu. Rep. Unpubl. Rep. by LGL for Arctic Project Office, Outer Cont. Shelf Envir. Assess. Program. Fairbanks, AK. 71p.

Craig, P.C. and L. Haldorson. 1981. Beaufort Sea barrier island-lagoon ecological process studies: Final Rep.. Simpson Lagoon. Part 4. Fish. Pages 384-678. Res. Unit 467. In: Environ. Assess. Alaskan Cont. Shelf, OCS Biol. Sci. Final Rep. Prin. Invest. Vol. 7. BLM/NOAA, OCSEAP, Boulder, CO.

Craig, P.C. and D. Schmidt. 1982- Fisheries surveys at potential dredging sites at North Slope villages: Wainwright, Point Lay, Atkasook, Nuiqsut and Kaktovik. Rep. by LGL Ltd. (Sidney) for the North Slope Borough, Barrow, Alaska.

Craig, P.C. and P. Skvorc. 1982. Fish resources of the Chukchi Sea: Status of existing information and field program design. Prepared for Arctic Project Office, NOAA/OCSEAP, Fairbanks, AK. 56 p.

Craig. P.C., W.B. Griffiths, L. Haldorson and H. McElderry. 1982. Ecological studies of Arctic cod (Boregadus saida) in Beaufort Sea waters, Alaska. Can. J. Fish and Aquatic Sci. 39:395-406.

Davis, R.A., K.J. Finley and W.J. Richardson. 1980- The present status and future management of arctic marine mammals in Canada. Science Advisory Board of the Northwest Territories, Rep. No. 3. Dep. Information, Government of the N.W.T. 93 p.

Divoky, G-J. 1976. The pelagic feeding habitsof ivory and Ross' gulls. Condor, 78:85-90.

Divoky, G.J. 1978. The distribution, abundance and feeding ecology of birds associated with pack ice. Annu. Rep. by Point Reyes Bird Observatory to NOAA/OCSEAP, Boulder, CO. Vol. 2:167-509.

Edsall, T.A. 19709 The effect of temperature on the rate of development and survival of alewife eggs and larvae. Trans. Amer. Fish. Sot. (2):376-380.

Fechhelm, R.G., W.H. Neill and B.J. Gallaway. 1983. Temperature preference of juvenile Arctic cisco (Coregonus autumnalis) from the Alaskan Beaufort Sea, in relation to salinity and temperature acclimation. Biological Papers of the Univ. of Alaska.

Fisher, K.C. and P.F. Elson. 1950. The selected temperature of Atlantic salmon and speckled trout and the effect of temperature on the response to an electrical stimulus. Physiol. Zool. 23:27-34.

Forrester. C.R. and D.F. Alderdice. 1966. Effects of salinity and temperature on embryonic development of the Pacific cod (Gadus macrocephalus). J. Fisheries Res. Board Can. 23:319-340.

Frost, K.J. and L.F. Lowry. 1983. Demersal fishes and invertebrates trawled in the Northeastern Chukchi and Western Beaufort seas 1976-1977. Tech. Rep. NOAA/NMFS. 22 P.

Frost. K.J., L.F. Lowry and J.J. Burns. 1978. Offshore demersal fishes and epibenthic invertebrates of the northeastern Chukchi and western Beaufort seas. Pages 231-365. In: Environ. Assess. Alaskan Cont. Shelf, Annu. Rep. Prin. Invest., Vol. 1. BLM/NOAA,OCSEAP, Boulder, CO.

Furniss, R. 1975. Inventory and cataloging of arctic area waters. Alaska Dep. Fish & Game, Annu. Rep. 16. 47 p.

Fry, F.E.J. 1947. Effects of environment on animal activity. Univ. Toronto Stud. Biol., Ser. 55; Publ. Ont. Fish. Res. Lab. No. 68. 62 p.

Fry, F.E.J. and J.S. Hart. 1949. Swimming speed of goldfish at different temperatures. J. Fish. Res. Board Can. 7:169-175.

Garside, E.T., D.G. Heinze and S.E. Barbor. 1977. Thermal preference in relation to salinity in the threespine sticklebacks, Gasterosteus aculeatus (L.), with an interpretation of its significance. Can. J. Zool. 55:590-594.

Geiger, M. 1966. Kotzebue chum salmon tagging project. Pages 78-93. In: Ayk area 1966 annual management report. Div. of Comm. Fish., Anchorage, AK.

Griffiths, W., P.C. Craig, G. Walder and G. Mann. 1975. Fisheries investigations in a coastal region of the Beaufort Sea (Nunaluk Lagoon, Y.T.). Arctic Gas Biol. Rep. Ser. 34(2). 219 P.

Griffiths, W., J. Denbeste and P. Craig. 1 977; Fisheries investigations in a coastal region of the Beaufort Sea (Kaktovik Lagoon, Barter Island, Alaska). Arctic Gas Biol. Rep. Ser. 40(2). 190 p.

Griffiths, W.B. and B.J. Gallaway. 1982. Prudhoe Bay Waterflood Project. Fish monitoring program. Unpubl. Rep. for Woodward-Clyde Consultants, Anchorage, AK. 142 p.

Griffiths, W. 1983. Fish. pages 176-222. In: Environmental characterization and biological use of lagoons in the eastern Beaufort Sea. Rep. by LGL Ecological Research Associates for Outer Continental Shelf Environmental Assessment Program, Office of Marine Pollution Assessment. Juneau, AK.

Griffiths, W.B., D.R. Schmidt, R.G. Fechhelm, B.J. Gallaway. 1983. In: B.J. Gallaway and R. Britch (eds.). Environmental summer studies (1982) for the Endicott Development. Vol. III. Fish Ecology. Rep. by LGL Alaska Research Associates and Northern Technical Services for Sohio Alaska Petroleum Co., Anchorage, AK. 342 p.

Hablett, T. 1979. Fish inventories conducted within the National Petroleum Reserve on the North Slope of Alaska, 1977-78. Chap. 10. Pages 337-406: In: Studies of selected wildlife and fish and their use of habitats on and adjacent to NPRA 1977-1978. Vol. 2.

Hachmeister, L. 1983. Rapid response of Alaska coastal water to strong meteorological forcing in the Chukchi Sea. EOS Vol. 64. No. 45. p. 7-40.

Hart, J- 1973. Pacific fishes of Canada. Bull. Fish. Res. Board Can. 180. 740 p.

Hettler, W.F. 1976. Influence of temperature and salinity on routine metabolic rate and growth of young Atlantic menhaden. J. Fish. Biol. 8:55-65

Ivie, P. and W. Schneider. 1979. Wainwright synopsis. Pages 75-87. In: Native livelihood and dependence. A study of land use values through time. U.S. Dep. Interior, National Petroleum Reserve in Alaska, 105(c) Field Study No. 1.

Jobling, M. 1981. Temperature tolerance and the final preferendum - rapid methods for the assessment of optimal growth temperatures. J. Fish. Biol. 19:439-455.

Jones, M.C. and J. DenBeste. 1978. Tuft Point and adjacent coastal area fisheries project. Unpubl. Rep. by Aquatic Environments Ltd. for Imperial Oil Limited. 152 p.

Kendel, R., R. Johnston, V. Lobsiger and M. Kozak. 1975. Fishes of the Yukon Coast. Beaufort Sea Tech. Rep. No. 6. 114 p*

Kinne, O. 1960. Growth, food intake, and food conversion in a euryhaline fish exposed to different temperatures and salinities. Physiol. Zool. 33:288-317.

Kinne, O. and E.M. Kinne. 1962. Rates of development in embryos of a cyprinodont fish exposed to different temperature-salinity-oxygen combinations. Can. J. Zool. D40:231-253.

Kogl, D. and D. Schell. 1974. Colville River Delta fisheries research. Pages 483-504. In: Environ. studies of an arctic estuarine system - Final Rep. U.S. Environ. Protect. Agency, Ec. Res. Ser. EPA-660/3-75-026.

Lebida, R. 1970. Kotzebue Sound sheefish investigations, 1970. Alaska Dep. Fish and Game, Arctic-Yukon-Kuskokwin Region. 12 p.

Lowry, L.F., K.J. Frost and J.J. Burns. 1979. Trophic relationships among ice-inhabiting phocid seals. Annu. Rep. by Alaska Dep. of Fish and Game for NOAA/OCSEAP, Boulder, CO., Vol. 1:161-230.

Lowry, F.L., K.J. Frost and J.J. Burns. 1980. Variability in the diet of ringed seals, Phoca hispida, in Alaska. Can. J. Fish. Aquat. Sci. 37:2254-2261.

Lowry, L.F. and K.J. Frost. 1981. Distribution, growth and foods of Arctic cod (Boreogadus saida) in the Bering, Chukchi and Beaufort seas. Canadian Field-Naturalist 95(2):186-191.

MacGinitie, G.E. ?955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. Smithsonian Misc. Coil. Vol. 128, No. 9.

McCauley, R.W., and J.M. Casselman. 1980. The final preeferendum as an index of the temperature for optimum growth in fish. From Proc. World Symp. on Aquiculture in Heated Effluents and Recirculation Systems, Stavanger 28-30 May, 1980. Vol. II. Berlin 1981.

McCormick, J.H., K.E.F. Hokanson and B.R. Jones. 1972. Effects of temperature on growth and survival of young brook trout, Salvelinus fontinalis. J. Fish. Res. Board Can. 29:1107-1112.

McInerney, J.E. 1964. Salinity preference: an orientation mechanism in salmon migration. J. Fish. Res. Board Can. 21(5):995-1018.

McKenzie, R.A. 1964. Smelt life history and fishery in the Miramichi River, New Brunswick. Bull. Fish. Res. Board Can. 144. 77 p.

McPhail, J.D. 1966. The Coregonus autumnalis complex in Alaska and northwestern Canada. J. Fish. Res. Board Can. 23:141-148.

Mohr, J.L., N.J. Wilimovsky and E.V. Dawson. 1957. An arctic Alaskan kelp bed. Arctic 10:45-52.

Morris, B. 1981. Living marine resources of the Chukchi Sea: A resource report for the Chukchi Sea oil and gas lease sale #85. Rep. by Nat. Mar. Fish. Serv. for Bureau of Land Management (Anchorage). 117 p.

Morrow, J. 1980. Freshwater fishes of Alaska. Alaska Northwest Publishing Company. Anchorage, AK. 248 p.

Moulton, L.L. and S. Bowden. 1981. Resource report for the proposed Chukchi Basin OCS oil and gas lease sale #85. Unpubl. Rep. by Alaska Dep. Fish and Game, Marine/Coastal Habitat Management, Anchorage, AK. 38 p.

Murdoch, J. 1884. Fish and fishing at Point Barrow, arctic Alaska. Trans. Am. Fish. Sot. 13:111-115.

Murdoch, J. 1885. Fishes. Pages 129-132. In: P. Ray (cd.). Report on the International Polar Expedition to Pt. Barrow, Alaska 1882-83. Part 4. Sec. 3. U.S. Gov. Printing Office, Washington, D.C.

Olla, B. 1980. Role of temperature in triggering migratory behavior of Tautog. Mar. Biol. 59:23-30.

Otwell, W.S. and J.V. Merringer. 1975. Survival and growth of juvenile striped bass, *Morone sakatilis*, in a factorial experiment with temperature, salinity and age. Trans. Am. Fish. Sot. 104:560-566.

Paulke. K. 1983. Biology of capelin, *Mallotus villosus*, in Alaskan waters. Paper presented at the Annual Meeting, Am. Fish. Sot., Alaska Chapter, Soldotna, November 14-17, 1983.

Pedersen, S. 1979. Point Hope synopsis. Pages 141-149. In: Native livelihood and dependence. A study of land use values through time. U.S. Dep. Interior, National Petroleum Reserve in Alaska, 105(c) Field Study No. 1.

Pedersen, S., D. Libbey, W. Schneider and C. Dementieff. 1979. Barrow-Atgasuk (Atkasook) synopsis. Pages 49-74. In: Native livelihood and dependence. A studyof land use values through time. U.S. Dep. Interior, National Petroleum Reserve in Alaska, 105(c) Field Study No. 1.

Percy, R. 1975. Fishes of the outer Mackenzie Delta. Beaufort Sea Tech. Rep. No. 8. 114 p.

Pereyra, W.T., R.J. Wolotira, Jr., T.M. Sample and M. Morin, Jr. 1977. Baseline studies of fish and shellfish resources of Norton Sound and the southeastern Chukchi Sea. Pages 229-287. In: Environ. Assess. Alaskan Cont. Shelf. Annu. Rep. Prin. Invest. Vol. 8. BLM/NOAA, OCSEAP, Boulder, CO.

Plumb, J.A. 1973. Effects of temperature on mortality of fingerling channel catfish (*Ictalurus punctatus*) experimentally infected with channel catfish virus. J. Fish. Res. Board Can. 30:568-570.

Quast, J.C. 1972. Preliminary report on the fish collected on WEBSEC-70. Pages 203-206. In: WEBSEC-70. an ecological survey in the eastern Chukchi Sea. U.S. Coast Guard, Oceanographic Rep. No. 50. 206 p.

Quast, J.C. 1974. Density distribution of juvenile Arctic cod, *Boreogadus saida*, in the eastern Chukchi Sea in the fall of 1970. Fish. Bull. 72:1094-1105.

Quast, J.C. and E.L. Hall. 1972. List of fishes of Alaska and adjacent waters with a guide to some of their literature. U.S. Dep. Corn merce. NOAA Tech. Rep. NMFS SSRF-658. 47 p.

Rae, G.M.M. 1968. Oxygen consumption of rainbow trout (Salmo gairdneri) in relation to activity and salinity. Can. J. Zool. 46:781-786.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Board Can. Bull. 191. 382 p.

Roguski, E. and P. Winslow. 1970. Monitoring and evaluation of arctic waters with emphasis on the North Slope drainages. Annu. Rep. No. 1 5-C. Alaska Dep. Fish and Game. 11:279-301.

Seaman, G. and J. Burns. 1980. Preliminary results of recent studies on belukhas in Alaskan waters. Unpubl. Rep. by Alaska Dep. Fish and Game (Fairbanks). 31 p.

Schmidt, D. and P.C. Craig. (In Press). Fish resources at Point Lay. Rep. by LGL for the North Slope Burough, Barrow, AK.

Schneider, W. and R. Bennett. 1979. Point Lay synopsis. Pages 107-119. In: Native livelihood and dependence. A study of land use values through time. U.S. Dep. Interior, National Petroleum Reserve in Alaska, 105(c) Field Study NO. 1.

Sekerak, A. 1982 Summary of the natural history and ecology of the arctic cod (Boreogadus saida). Species Account Rep. by LGL Limited for BLM/NOAA.OCSEAP. 10 p.

Shelbourn, J.E., J.R. Brett and S. Shirahata. 1973* Effect of temperature and feeding regime on the specific growth rate of sockeye salmon fry (Oncorhynchus nerka), with a consideration of size effect. J. Fish. Res. Board Can. 30:1191-1194.

Skvorc, P.A. 1982- Winter subsistence fishing at villages along the northeast Chukchi coastline. Unpubl. Field Rep. by LGL Limited.

Springer, A.M. and D.G. Roseneau. 1978. Ecological studies of colonial seabirds at Cape Thompson and Cape Lisburne, Alaska. Pages 839-960. In: Environ. Assess. Alaskan Cont. Shelf. Annu. Rep. Prin. Invest. vol. 20 BLM/NOAA,OCSEAP, Boulder, CO.

Springer, A.M. and D.G. Roseneau. 1979. Ecological studies of colonial seabirds at Cape Thompson and Cape Lisburne, Alaska. Pages 517-574. In: Environ. Assess. Alaskan Cont. Shelf. Annu. Rep. Prin. Invest. vol. 2. BLM/NOAA,OCSEAP, Boulder, CO.

Smith, H.D., A.H. Seymour and L.R. Donaldson. 1966. The salmon resource. vol. 2, Chap. 31. Pages 861-871. In: N.J. Wilimovsky and J.N. Wolfe (eds.). Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Commission, U.S. Dep. Commerce, Springfield, VA.

Swartz, L.G. 1966. Sea cliff birds. Vol. 2, Chap. 23. Pages 611-678. In: N.J. Wilimovsky and J.N. Wolfe (eds.). Environment of the Cape Thompson region, Alaska. U.S. Atomic Energy Commission, U.S. Dep. Commerce, Springfield, VA.

Thorsteinson, F.V. 1962. Herring predation on pink salmon fry in a southeastern Alaska estuary. Trans. Amer. Fish. Sot. 91(3):321-323.

Walters, V. 1955- Fishes of western arctic America and eastern arctic Siberia. Bull. Am. Mus. Nat. Hist. 106:255-368.

Walters, V. 1961. Winter abundance of Arctogadus glacialis in the Polar Basin. Copeia 2:236-237.

Westin, L. 1970. The food ecology and the annual food cycle in the Baltic population of fourhorn sculpin, Myoxocephalus quadricornis (L.) Pices. Rep. Inst. Freshwater Res. Drottningholm 50:168-210.

Wilimovsky, N.J. 1956. The utilization of fishery resources by the arctic Alaskan Eskimo. Nat. Hist. Mus. Stanford Univ., Occas. Pap. No. 2. 8 p.

Wilson, D.E., S.D. Pace, P.D. Carpenter, H. Peas, P. Goddard, T. Wilke and P. Kinney. 1981. Nearshore currents, Chukchi Sea 1981. Univ. Alaska Final Rep. NOAA/OCSEAP, Fairbanks, AK.

Wilson. D.E., S.D. Pace, P.D. Carpenter, H. Peas, P. Goddard, T. Wilke and P. Kinney. 1981. Nearshore currents, Chukchi Sea 1981. Univ. Alaska. Final Rep. NOAA/OCSEAP, NA-79 RAC 00086.

Winslow, P. 1969. Investigation and cataloging of sport fish and sport fish waters in interior Alaska - char in northwestern Alaska. Annu. Rep. No. 15-A. Alaska Dep. Fish and Game. 10:319-3321.

Wilson, W.J., Jr., J.N. Suhayda, S.A. Hsu and C.D. Watters, Jr. 1974. Characteristics of nearshore oceanographic environments of arctic Alaska. Pages 49-64. In: Coast and shelf of Beaufort Sea. Arctic Instit. of N. Amer.

Wohlschlag, D.E. 1956. Information from studies of marked fishes in the Alaskan Arctic. Copeia 4:237-242.

10.0 APPENDICES

10.1 Physical Data Listings

This section contains temperature, salinity and turbidity data measured during the 16-25 March winter study and the Point Lay summer study.

physical Data: Winter study

DATE	STATION	DEPTH (m)	TEMPERATURE (°C)	SALINITY (‰)	TURBIDITY (NTU)
3/18	1	S	-0.5	32.0	1.5
		6		35.0	3.0
	2	S	-0.5	28.9	3.0
		5		28.9	5.5
		10		27.3	3.2
3/19	2	S	-0.5	28.2	5.0
3/20	2	S	-0.5	28.1	1.2
	3	S	-0.5	33.0	1.5
3/21	2	S	-0.5	28.2	2.6
	3	S	-0.5	29.0	2.3
3/22	2	S	-1,0	33.3	0.8
	3	S	-1.0	25.1	2.3
		5		20.9	2.3
		10		16.5	2.7
3/23	3	S	-1.0	28.0	1.3
3/24	4	S	-1.0	29.7	0.6
3/25	4	S	-1.0	30.0	0.5
3/26	4	S	-0.5	29.8	4.3
	H	S	-0.5	27.8	4.6
3/27	4	S	-1.0	31.0	0.4
		5		30.0	0.4
		10		30.1	1.1
3/28	4	S	-1.0	31.0	14.1

Temperature(°C): Pt. Lay summer study

Station:	Fyke 1	Fyke 2	Gill 3	Gill 4*	Gill 5	Gill 6	Gill 7	Gill 8	Dav Mean
Date									
7/18/83	1.0	7.5		-					4.3
7/19/83	1.5	10.0		-					5.8
7/20/83	7.1	9.5		-					8.3
7/21/83	6.0	11.5		-	10.0				9.2
7/22/83	8.5	10.0		-	10.8				9.8
7/23183	4.5	11.5		-	9.5				8.5
7/24/83		11.5		-	11.5				11.5
7/25/83	1.9	10.0		-	11.0				7.6
7126[83	2.5			-					2.5
7/27183				-					-
7128/83	3.0	10.9		-					7.0
7/29183	3.0	12.2		-					7.6
7/30/83	3.0	13.2	4.4	-					6.9
7131/83		11.7		-					11.7
8/1/83	6.0	12.0		-					9.0
8/2/83	10.5	12.0		-	12.0				11.5
8/3/83	9.0	12.0		-		11.0			10.7
8/4/83	8.0	11.5		-					9.8
8/5/83	7.5	7*O		-					7.3
8/6/83	8.5	8.5		-					8.5
8/7/83		9.0		-	9.0				9.0
8/8/83		9.5		-		10.5	-		10.0
8/9/83				-			8.0		8.o
8/10/83				-					
8/11/83	9.0	12.5	10.0	-					10.5
8/12/83		12.0		-					12.0
8/13/83		10.0		-					10.0
8/14/83		8.0		-					8.o
8/15/83	3.0	5.0		-					4.0
8/16/83	3.0	9.0		-					6.0
8/17183		8.0	3.0	-					5.5
8/18/83		6.5		-					6.5
8/19/83	7.0	7.5	6.0	-	7.5				7.0
8120/83	7.0	7.5		-					7.3
8/21/83				-					
8/22/83	8.0	5.0		-				-	6.5
8/23183	6.0	5.4		-				6.5	6.0
8/24/83	6.5	4.5		-	.5				3.8
8/25183		4.0	6.0	-	4.0				4.7
8/26/83		6.5		-	6.0		7.5		6.7
8/27183				-					
8/28/83		4.5		-		4.5			4.5
8/29/83		4.5	1.5	-	4.5		4.0		3.6
8/30/83		3.5		-	3.5				3.5
8/31/83				-			-	-	3.0
Mean	5.6	8.7	5.2	-	7.7	8.7	6.5	6.5	7.4
Std. Dev.	2.76	2.97	2.95	-	3.65	3.62	2.18	0.00	3.24
Std. Err.	.55	.48	1.20	-	1.01	2.09	1.26	0.00	.34
N	25	39	6	-	13	3	3	1	90

●Gill net station 4 ❑Fyke net station 1

Salinity (%o) : Pt. Lay **summer study**

	Fyke		Gill						Day
Station:	1	2	3	4*	5	6	7	8	Mean
Date									
7/18/83	26.0	23.9		-					25.0
7/19/83	27.5	22.4		-					25.0
7/20/83	21.5	20.6		-					21.1
7/21/83	19.5	20.3		-	15.5				18.4
7/22/83	20.6	19.5		-	13.1				17.7
7/23/83	26.2	20.7		-	20.5				22.5
7/24/83		20.2		-	22.7				21.5
7/25/83	28.5	20.1		-	19.0				22.5
7/26183	28.0			-					28.0
7127{83				-					
7/28/83	28.3	26.5		-					27.4
7/29/83	26.5	13.5		-					20.0
7/30/83	25.0	13.0	24.0	-					20.7
7'/31/83	25.2	8.0	24.0	-					19.1
8/1/83	28.3	18.1		-					23.2
8/2/83	20.0	17.8		-	16.3				18.0
8/3/83	20.0	14.8		-		22.0			18.9
8/4/83	23.0	21.8		-					22.4
8/5/83	21.0	26.5		-					23.8
816183	21.0	18.5		-					19.8
8/7/83	21.5	17.5		-	16.0				18.3
8/8/83		23.0		-		20.0			21.5
8/9/83		22.5		-			22.3		22.4
8/10/83		16.0		-					16.0
8/11/83	21.5	9.0	20.0	-					16.8
8/12/83		1.0		-					1.0
8/13/83		21.5		-					21.5
8/14/83				-					
8/15/83				-					
8/16/83	26.5	21.0		-					23.8
8/17/83		9.0	25.0	-					17.0
8/18/83		22.0		-	22.0				22.0
8/19183	19.0	14.0	26.0	-	13.0				18.0
6/20/83	22.5	14.0		-					18.3
8/21183				-					
8/22183	23.7	15.5		-					19.6
8/23/83	21.0	12.0		-				15.8	16.3
8/24/83	24.0	22.5		-	6.8				17.8
8/25/83		2.0	23.4	-	.7				8.7
8126183		18.2		-	4.8		22.4		15.1
8/27/83				-					
8/28/83		2.9		-		5.4			4.2
8/29183		0.0	22.8	-	0.0		0.0		5.7
8130183		1.2		-	0.0				.6
8/31/83		14.8		-	-	-	-	-	14.8
Mean	23.7	16.0	23.6	-	12.2	15.8	14.9	15.8	18.1
Std. Dev.	3.13	7.23	1.90	-	8.22	9.06	12.90	0.00	7.63
std. Err.	.61	1.16	.72	-	2.20	5.23	7.45	0.00	.79
N	26	39	7	-	14	3	3	1	93

•Gill net station 4 = Fyke net station 1

Turbidity (NTU): Pt. Lay summer study

	Fyke				Gill				Day
station:	1	2	3	4*	5	6	7	8	Mean
Date									
7/18/83	2.9	7.5		-					5.2
7/19/83	2.3	4.9		-					3.6
7/20/83	3.8	4.1		-	-				4.0
7/21/83	4.6	3.1		-	8.2				5.3
7122/83	3.2	3.4		-	5.3				4.0
7/23/83	1.1	2.5		-	2.3				2.0
7124183		4.3		-	3.4				3.9
7/25/83	1.5	14.0		-	16.0				10.5
7/26/83	54.0			-					54.0
7127183				-					
7/28/83	27.0	43*O		-					35.0
7/29/83	5.0	5.6		-					5.3
7/30/83	2.9	10.5	2.3	-					5.2
7/31/83	1.4	14.5	1.3	-					5.7
8/1/83	1.8	3.0		-					2.4
812183	3.2	7.0		-	15.0				8.4
8/3/83	3.5	4.8		-		3.1			3.8
8/4/83	5.0	3.6		-					4.3
8/5183	2.2	3.1		-					2.7
8/6/83	9.5	7.0		-					8.3
8/7/83	9.6	7.8		-	8.5				8.6
8/8/83		2.5		-		5.8			4.2
8/9/83		7.8		-			24.0		15.9
8/10/83		3.0		-					3.0
8/11/83	3.2	32.0	5.6	-					13.6
8112183		120.0		-					120.0
8/13/83	·	6.4		-					6.4
8/14/83	·			-					
8/15/83		-		-					
8/16/83	4.5	6.0		-					5.3
8/17/83		13.0	1.8	-					7.4
8/18/83	·	15.0		-	1.5				8.3
8/19/83	16.0	20.0	5.0	-	5.0				11.5
8/20183	10.0	11.0		-					10.5
8/21/83	·	-		-					
8/22/83	22.0	6.7		-				-	14.4
8/23/83	10.0	11.0		-				18.0	13.0
8/24/83	17.0	8.5		-	20.0				15.2
8125183		19.0	3.9	-	22.0				15.0
8/26/83		10.0		-	25.0		19.5		18.2
8/27/83				-					
8/28/83	-	54.0		-		38.o			46.0
8/29/83		140.0	6.9	-	135.0		14.9		74.2
8/30/83		135.0		-	94.0				114.5
8/31/83		36.0	-	-	-	-	-	-	36.0
Mean	8.7	20.8	3.8	-	25.8	15.6	19.5	18.0	16.7
Std. Dev.	11.41	34.46	2.11	-	39.17	19.42	4.55	0.00	28.32
Std. Err.	2.24	5.52	.80	-	10.47	11.21	2.63	0.00	2.94
N	26	39	7	-	14	3	3	1	93

•Gill net station 4 = Fyke net station 1

Physical Data: Discoverer Cruise

Station	Date	Latitude	Longitude	Depth (m)	Temperature (°C) Surface	Temperature (°C) Bottom	Salinity (ppt) Surface	Salinity (ppt) Bottom
1	8/26	69°51.2' N	166°51.5' W	43	8.9	5.8	30.2	31.0
2	8/27	69 °46.6 '	163°13.4'	17	6.8	6.8	28.6	28.6
3	8/27	69°49.4'	163°30.5'	24	7.0	4.5	28.7	30.0
4	8/27	69°48.3'	163016.5'	17	7.0	7.0	28.7	28.7
5	8/28	69053.5,	163°56.3'	27	6.6	2.4	29.9	30.6
6	8/28	69047.2'	163°15.9'	16	6.7	-	28.'7	
7	8/29	69°49.2'	163029.4'	23	6.8	6.8	28.6	28.6
8	8/29	69°52.2'	163°67.4'	27	6.4	2.3	29.8	30.6
9	8/30	70°06.8'	165018.5'	40	6.3	4.3	30.7	31.0
10	8/30	70006.41	165018.8'	41	5.7	4.0	30.8	31.0
11	8/30	69052.9'	163059.6 '	31	5.8	2.4	29.9	30.8
12	8/31	69048.5'	163026.8'	24	6.4	6.5	28.7	29.3
13	9/1	70°07.6'	162043.8'	15	6.0	6.0	28.9	29.8
14	9/1	?0030.7'	160°30.5'	17	4.8	4.8	29.3	29.3
15	9/1	70°38.1'	160009.9'	18	4.8	5.0	29.3	29.5
16	9/2	70°37.8'	160018.8'	22	5.3	5.3	27.0	27.0
17	9/2	70°43.4'	160029.1'	43	2.9	4.6	29.5	30.9
18	9/2	70°42.8'	160029.9'	42	3.1	4.5	30.0	30.6
19	9/2	70°39.3'	160018.5'	23	5.2	5.2	30.0	30.0
20	9/2	70°39 .2'	160006.3 '	19	4.8	4.7	29.3	29.3
21	9/3	70°40.8'	160017.5'	25	5.2		30.1	
22	9/4	70°40.8'	161058.8'	41	3.3	4"0	30.7	31.3
23	9/4	70°54.8'	161057.4'	45	0.2	0.5	29.6	31.7
24	9/5	71003.8'	158056.3'	55	0.2	4.0	29.6	30.8
25	9/6	70°18.0'	166031.3'	46	1.8		28.9	
26	9/7	69 °46.6 '	168°31.5'	52	1.6		28.8	32.5
27	9/7	69°36.3'	168°26.7'	51	3.0	0.9	30.8	32.6
28	9/8	69059.1 '	166025.6 '	46	3.0	2.6	30.2	31.8
29	9/8	69045.1 '	167°29.6'	48	2.2	1.3	29.3	32.1
30	9/8	69038.6 '	167028.4'	48	3.8	1.6	30.2	32.0
31	9/8	7 0°23.3'	167041.1'	50	0.2	-0.8	27.5	32.2
32	9/9	69 °46.1 '	168030.6'	51	2.0	1.0	29.0	32.6
33	9/9	69°24.1'	168029.1 '	52	2.7	3.4	31.6	32.0
34	9/9	68°59.2'	168025.6'	52	6.1	4.0	30.5	31.3
35	9/9	69°00.5'	167°30.2'	48	5.8	3.8	30.4	31.4
36	9/9	69°00.0'	166°33.5'	36	7.1	6.7	30.2	30.9
37	9/9	68°58.7'	165032.5'	18	6.8	6.3	29.5	29.5
38	9/1 o	69°01.8'	165°40.0'	20	7.0	7.0	29.8	29.9
39	9/1 o	69°10.9'	165°35.2'	30	6.8	6.8	30.1	30.4
40	9/1 o	69°11.0'	165035.6'	28	6.8	6.9	30.2	30.2
41	9/10	68059.5?	165°32.7?	18	6.6	6.6	29.5	29.5
42	9/1 o	68°58.9'	165032.1?	19	6.5	6.5	29.5	29.5
43	9/11	69°01.8'	165032.3'	22	6.6	6.9	29.6	30.0
44	9/1 1	69°11.0'	165°34.0'	27	6.7	6.9	30.0	30.2
45	9/1 1	69°40.4'	165027.6'	39	5.8	4.5	27.8	31.0
46	9/1 1	69011.2'	165033.9'	47	6.4		29.9	
47	9/11	69°01.3'	165°33.7'	21	6.4	6.9	29.4	30.0
48	9/12	68°49.9'	166°23.3'	33	6.4	5.9	29.3	31.0
49	9/12	68°01.6'	166007.7 '	25	7.5	7.5	30.4	30.5

10.2 Winter Catch Data Listings

This section contains length, body weight, and stomach content wet weight data for the 204 Arctic cod taken during the 16-25 March sampling period. Stomach contents indicated as 0.01 g include all weights less than or equal to 0.01 g.

Winter Fyke Nets: ARCTIC COD

Station	Date	Weight (g)	Fork Length (mm)	Weight of Stomach Contents(g)
i	3/16/83	4.27	80	0.02
		1.32	55	0.01
2	3/18/83	3.97	80	
		3.24	75	
		4.17	80	
		2.00	65	
		2.56	70	
		2.03	64	
		1.72	65	
		5.41	90	
		1.96	64	
		1.85	63	
		2.16	67	
		1.93	67	
		2.93	75	
		2.08	67	
		2.30	67	
		1.48	60	
		1.68	61	
		1.84	63	
2	3/19/83	2.49	66	
		2.48	67	
		2.76	69	
		1.44	58	
		3.23	75	
		2.91	70	
		3.47	74	
		2.45	65	
		1.77	63	
		2.74	66	
		2.30	65	
		1.54	62	
		5.13	82	
		2.27	67	
		3.70	75	
		1.87	60	
		2.76	67	
		2.31	60	
		2.19	67	
		2.35	68	
		2.37	67	
		2.03	65	
		3.41	71	
		2.74	70	
		1.92	65	
		1.65	60	
		1.96	64	
		2.74	68	
		2.42	67	
		2.64	70	
		3.06	72	

Winter Fyke Nets: ARCTIC COD

Station	Date	Weight (g)	Fork Length (nun)	Weight of Stomach Contents(g)
2	3/19/83	1.47	58	
		1.93	64	
		2.05	64	
		2.14	63	
		1.10	53	
		1.33	55	
		1.03	53	
2	3/20/83	7.68	99	
		3.57	75	
		1.57	60	
		2.43	69	
		2.86	75	
		2.07	67	
		1.71	60	
		4.25	79	
		2.45	70	
		2.43	67	
		2.87	70	
		2.59	58	
		1.24	56	
		1.50	60	
		1.74	60	
		3.97	78	
		2.20	62	
		1.96	61	
		2.38	65	
		3.26	75	
		2.24	66	
		2.22	62	
		2.08	62	
		2.24	68	
		2.42	67	
		2.44	70	
		2.31	68	
		1.13	55	
2	3/21/83	3.38	74	0.01
		2.91	70	0.01
		2.40	66	0.01
		2.89	68	0.01
		2.21	66	0.01
		2.05	66	0.01
		2.56	68	0.08
		2.50	68	0.00
		2.33	64	0.06
		2.19	65	0.01
		1.95	63	0.01
		1.50	59	0.01
		1.95	64	
		1.63	61	
		1.62	61	
		1.61	61	
		0.97	54	
		1.31	55	
		1.55	58	
		1.95	64	

Winter Fyke Nets: ARCTIC COD

Station	Date	Weight (g)	Fork Length(m)	Weight of Stomach Contents(g)
2	3/21/83	1.20	58	
		1.93	60	
		1.58	60	
		4.85	80	0.05
		5.70	90	0.05
		1.43	62	0.02
		1.02	51	0.00
		4.44	84	0.01
		0.53	44	0.01
		4.00	78	
		4.70	83	
		3.05	74	
		3.42	78	
		2.52	69	
		4.14	80	
		4.48	80	
		2.75	68	
		2.61	69	
		2.97	73	
		2.29	66	
		1.94	63	
		1.95	60	
		2.52	68	
		3.96	75	
		2.22	65	
		2.86	70	
		3.06	70	
		2.75	69	
		1.62	62	
		1.97	66	
		1.82	63	
		1.97	62	
		1.61	62	
		1.40	60	
		1.72	60	
		1.59	59	
		1.62	57	
2	3/22/83	5.84	94	0.04
		4.81	87	0.01
		1.89	64	0.01
		2.63	70	0.01
		1.86	62	0.00
		1.78	67	0.01
		1.47	60	0.00
		1.12	57	0.01
		1.89	62	0.01
		1.39	60	0.01
		1.47	57	0.02
		0.81	50	0.00
		1.63	62	0.00
		1.01	55	0.00
		0.82	48	0.01

Winter Fyke Nets: ARCTIC COD

Station	Date	Weight (g)	Fork Length (mm)	Weight of Stomach Contents(g)
3	3/21/83	3.28	70	0.28
		2.59	68	0.09
		2.47	65	0.06
		2.08	64	0.06
		1.47	57	0.02
		2.37	67	0.03
		1.71	60	0.04
		1.54	60	0.03
		1.15	54	0.02
		2.68	70	0.03
		1.29	60	0.03
		2.52	70	0.06
		1.37	59	0.05
		2.47	69	0.06
		1.24	55	0.01
		1.25	57	0.00
		1.31	58	0.00
		2.09	60	0.00
		1.69	62	0.06
	3/22/83	2.64	70	0.04
		3.28	72	0.05
		2.29	66	0.06
		1.47	59	0.04
3	3/23/83	2.38	65	0.05
		2.53	70	0.04
		2.31	66	0.04
4	3/25/83	4.47	80	0.24
		2.43	60	0.15
		1.04	49	0.02
		1.12	50	0.01
		1.01	49	0.01
4	3/26/83	2.62	62	0.18
		2.75	66	0.11
4	3/27/83	1.91	59	0.10
		1.96	58	0.08
4	3/28/83	4.47	77	0.37
		2.54	66	0.11
		2.48	65	0.07
		4.33	75	0.20
		2.52	64	0.18
		1.39	58	0.09
		4.37	79	0.26

10.3 Fish Catch and Effort Data Listings (Point Lay)

This section contains the fishing effort and catch by gear type for the 1983 Point Lay sampling period. The actual catch of the most abundant species taken at each station is given on a daily basis. Data is provided for the following species:

Fyke Nets	Gill Nets
Arctic cod	Pacific herring
Capelin	Boreal smelt
Fourhorn sculpin	Fourhorn sculpin
Arctic flounder	Arctic flounder
Boreal smelt	
Saffron cod	

EFFORT SUMMARY - FYKE NETS (Hours Fished)

Station:	1	2	
Date			
7/18/83	23.5		
7/19/83	20.3		
7/20/83	26.0		
7/21/83	22.5		
7/22/83	23.6		
7/23/83	24.5		
7/24/83			
7/25/83			
7/26183	71.3		
7127183			
7128/83			
7/29/83	26.5		
7/30/83	21.5		
7131183	22.5		
8/1/83	22.5		
8/2/83	29.6		
813183	19.0		
8/4/83	24.5		
8/5/83			
8/6/83			
8/7/83			
8/8/83			
8/9/83			
8110/83			
8/11/83			
8/12/83			
8/13/83			
8/14/83			
8/15/83			
8/16/83			
8/17183			
8/18183			
8/19/83		20.0	
8120183		19.5	
8/21/83			
8/22{83		47.0	
8/23/83			
8/24183		46.5	
8/25/83		24.0	
8126/83		29.5	
8/27183			
8/28/83		50.0	
8/29/83		21.0	
8130183		23.0	
8/31/83		24.5	
Mean	27.0	30.5	
Std. Dev.	13.0	12.3	
Std. Err.	3.29	3.90	
N	14	10	
Total	377.8	305.0	682.8

EFFORT SUMMARY - GILL NETS (Hours Fished)

Station: Date	3S	3B	4S	4B	4XS	4XB	5	6	7	8	Total
7/18/83			30.0	30.0							60.0
7/19/83	23.0	23.0									46.0
7/20/83				23.2							23.2
7/21/83							19.8				19.8
7/22/83							21.3				21.3
7/23/83							24.5				24.5
7/24/83							25.0				25.0
7/25/83							22.8				22.8
7/26/83			24.0	-							24.0
7/27/83											0.0
7128/83			50.0	50.5							100.5
7/29/83			25.3	25.5							50.8
7/30/83	24.3	24.3									48.6
7/31/83	18.5	18.5									37.0
7/1/ö3				23.0		25.0					48.0
8/2183							21.3				21.3
8/3/83						23.5		23.0			46.5
8/4/83					24.0						24.0
8/5/83											0.0
8/6/83											0.0
8/7/83											0.0
8/8/83									20.0		20.0
819/83										24.0	24.0
8/10/83											0.0
8/11/83	24.0			24.0							48.0
8112/83											0.0
8/13/83											0.0
8/14/83											0.0
8/15/83						20.5					20.5
8/16/83							28.0				28.0
8/17183	19.3	19.3									38.6
8/18/83							24.0				24.0
8/19/83	53.0	53.0					24.0				130.0
8/20/83			21.0	21.0			20.0				62.0
8/21/83											0.0
8/22/83			47.0	47.0			20.0				114.0
8/23/83			24.5	24.o						24.5	73.0
8/24183			29.0	29.0							58.0
8/25/83	20.0	20.5					21.5				62.0
8/26/83							22.5		22.5		45.0
8/27/83											0.0
8128/83								21.0			21.0
8/29/83	72.0	72.0					72.0		72.0		288.0
8130/83							24.0				24.0
8131/83											0.0
9/1/83	-	-	-	72.0	-	-	-	-	-	-	72.0
Mean	31.8	32.9	31.4	33.6	24.0	23.0	26.0	22.0	38.2	24.3	
Std. Dev.	19.8	21.0	11.0	16.1	24.0	2.3	12.9	1.4	29.3	.4	
Std. Err.	7.0	7.9	3.9	4.9	24.o	1.3	3.3	1.0	16.9	.3	
N	8	7	a	11	1	3	15	2	3	2	
Total	254.1	23o.6	250.8	369.2	24.0	69.0	390.7	44.0	114.5	48.5	1795.4

Catch Summary: Fyke Nets

Species	Station 1	Station 2	Total
Arctic cod	4014	1191	5205
Capelin	3343	1	3344
Fourhorn sculpin	1491	1152	2643
Arctic flounder	1512	202	1714
Saffron cod	110	155	265
Boreal smelt	1	79	134
Great sculpin	24	1	25
Pink salmon	5	1	6
Arctic char	2	1	3
Least cisco	2		2
Longhead dab	1		1
Bering cisco		1	1
Pacific sand lance		1	1
Threespine sticklebacks		1	1
	10,505	2840	13,345

Catch Summary: Gill Nets

Species	Station 3	4	4X	5	6	7	8	Total
Pacific herring	39	201	137	21	0	49	80	527
Fourhorn sculpin	0	58	59	21	19	16	29	202
Boreal smelt	1	77	0	7	20	15	66	186
Arctic flounder	0	11	13	18	50	3	1	96
Pink salmon	0	1	22	0	0	0	5	28
Capelin	0	6	9	0	0	0	1	16
P.retie cod	1	9	0	0	0	0	2	12
Longhead dab	0	4	5	0	0	1	1	11
Great sculpin	0	2	0	0	0	1	2	5
Saffron cod	0	1	0	1	0	0	2	4
Sturgeon poacher	0	2	0	0	0	0	1	3
Bering cisco	0	0	1	0	0	0	0	1
Chum salmon	0	0	0	0	0	1	0	1
	41	372	246	68	89	86	190	1092

FYKE NETS: Arctic Cod

Station: Date		2
7/18/83	119	
7/19/83	709	
7/20/83	99	
7121/83	287	-
7/22/83	164	
7/23/83	385	
7/24183		
7/25/83		
7/26/83	476	
7/27/83		
7/28/83		
7/29/83	296	
7/30/83	66	
7/31/83	28	
8/1/83	15	
812/83	866	
8/3/83	375	
8/4/83	129	
8/5/83		
8/6/83		
8/7/83		
8/8/83		
8/9/83		
8/10/83		
8/11/83		
8/12/83		
8/13/83		
8/14/83		
8/15/83		
8/16/83		
8/17/83		
8/18/83		
8/19/83		335
8/20/83		86
8/21/83		-
8/22/83		64
8/23/83		
8/24/83		43
8/25/83		31
8126/83		475
8/27/83		
8/28/83		115
8/29/83		6
8/30/83		1
8/31/83	-	35
Total	4014	1191
	5205	

FYKE NETS: Capelin

Station: Date		2
7/18/83	0	
7/19183	0	
7/20183	0	
7/21/83	0	
7/22/83	0	
7'/23183	0	
7/24/83		
7/25/83		
7/26/83	0	
7/27/83		
7128/83		
7/29/83	1	
7/30/83	1	
7/31/83	0	
8/1/83	134	
8/2/83	2698	
8/3/83	498	
8/4/83	11	
8/5183	.	
8/6/83		
8/7/83		
8/8/83		
8/9/83		
8/10/83		
8/11183		
8/12/83		
8/13/83		
8/14/83		
8/15/83		
8/76/83		
8/17/83		
8/18/83		
8/19/83		0
8120/83		0
8/21183		
8/22/83		0
8/23/83		
8/24/83		0
8/25/83		0
8/26/83		0
8/27/83		
8/28/83		0
8/29/83		0
8130183		0
8/31/83	-	1
Total	3343	1
	3344	

FYKE NETS: Fourhorn Sculpin

Station: Date	1	2
7/18/83	30	
7/19/83	304	
7/20/83	86	
7/21/83	161	
7122/83	277	
7123/83	242	
7/24/83		
7/25/83		
7/26/83	16	
7/2"1/83		
7/28/83		
7/29/83	5	
7/30/83	16	
7/31183	0	
8/1/83	60	
8/2/83	53	
813/83	230	
8/4/83	11	
815/83		
8/6/83		
817/83		
8/8/83		
8/9/83		
8110/83		
8/11183		
8112183		
8/13/83		
8/14183		
8/15/83		
8/16/83		
8/17/83		
8118/83		
8/19/83		90
8120/03		119
8/21/83		
8/22/83		94
8123/83		
8/24/83		66
8/25/83		33
8/26/83		50
8127/83		
8128/83		525
8/29/83		78
8/30/83		49
8/31/63	-	48
Total	1491	1152
	2643	

FYKE NETS: Arctic Flounder

Station: Date	1	2
7/18/83	5	
7/19/83	67	
7120183	27	
7/21/83	188	
7/22/83	109	
7/23183	92	
7/24/83		
7/25/83	-	
7/26/83	57	
7/2'[/83		
7/28/83		
7/29/83	65	
7/30183	13	
7/31/83	36	
8/1/83	752	
8/2/83	27	
8/3/83	63	
8/4/83	11	
8/5/83		
8/6/83		
8/7/83		-
818/83		
8/9/83		
8/10/83		
8/11/83		
8/12/83		
8113183		
8/14/83		
8/15/83		
8/16/83		
8/17/83		
8/18/83		
8/19/83		18
8120/83		63
8/21183		
8/22183		17
8/23/83		
8/24/83		25
8/25/83		2
8/26/83		18
8/27/83		
8/28/83		46
8/29/83		0
8/30183		2
8/31/83	-	11
Total	1512	202
	1714	

FYKE NETS: Saffron Cod

Station: Date	1	2
7/18/83	0	
7/19/83	0	
7/20183	0	
7/21/83	1	
7/22183	0	
7123/83	5	
7124183		
7/25/83		
7/26183	24	
7/27/83		
7/28/83		
7/29183	0	
7130/83	0	
7/31/83	1	
8/1/83	66	
8/2/83	1	
8/3/83	12	
8/4/83	0	
8/5183		
8/6/83		
817/83		
8/8/83		
8/9/83		
8/10/83		
8/11/83		
8/12/83		
8113/83		
8/14/83		
8/15/83		
8/16/83		
8117/83		
8118/83		
8/19/83		0
8/20/83		22
8/21/83		
8/22/83		21
8/23/83		
8124/83		29
8/25/83		2
8/26/83		29
8/27/83		
8/28/83		43
8/29183		3
8/30/83		0
8/31/83	-	6
Total	110	155
	265	

FYKE NETS: Boreal Smelt

Station: Date	1	2
7/18/83	0	
7/19/83	1	
7/20/83	0	
7/21/83	0	
7122183	0	
7/23/83	0	
7/24/83		
7/25/83		
7/26/83	0	
7127/83		
7128183		
7129/83	0	
7/30/83	0	
7131/83	0	
8/1/83	0	
8/2/83	0	
8/3/83	0	
8/4/83	0	
8/5/83		
8/6/83		
8/7/83		
8/8/83		
8/9/83		
8/10/83		
8/11/83		
8/12/83		
8/13/83		
8/14/83		
8/15/83		
8/16/83		
8/17/83		
8/18/83		
8/19/83		'8
8/20/83		16
8/21/83		
8122183		1
8/23/83		
8/24/83		4
8125183		44
8126183		6
8/27/83		
8/28/83		44
8/29/83		6
8/30/83		3
8/31/83	-	1
Total	1	133
	134	

GILL NETS: Fourhorn Sculpin

Station: Date	3	4	4X	5	6	7	8	Total
7/10183		0						0
7/19/83	0							0
7/20/63		0						0
7121/83				0				0
'1/22/83				1				1
7/23/83				0				0
7/24/83				4				4
7/25/83				0				0
7/26183		0						0
7/27/83								0
7/28/83		0						0
7/29/83		0						0
7/30/83	0							0
7/31/83	0							0
7/1/83		3	0					3
8/2/83				3				3
8/3/83			56		19			75
8/4/83			0					0
8/5/83								0
8/6/83								0
8/7/83								0
8/8183						2		2
8/9/83							17	17
8/10/83								0
8/11/83	0	13						13
8/12/83								0
8/13/83								0
8/14/83								0
8/15183			3					3
8/16/83				0				0
8/17/83	0							0
8118/83				2				2
8/19/83	0			1				1
8/20183		0		0				0
8/21/83								0
8/22/83		7		0				7
8/23/83		3					12	15
8/24/83		14						14
8/25/83	0			2				2
8/26/83				2		12		14
8127/83								0
8128/83					0			0
8/29/83	0			4		2		6
8/30/83				2				2
8/31/83								0
9/1/83	-	18	-	-	-	-	-	18
Total	0	58	59	21	19	16	29	202

GILL NETS: Arctic Flounder

Station: Date	3	1	-4X-	-L-	-6-	-L- - -	4 -	Total
7/18/83		0			-			0
7/19/83	0				-			0
7/20/83		0			-			0
7/21/83				0	-			0
7/22/83				9	-			9
7123/83				0	-			0
7/24/83				1	-			1
7/25/83				0	-			0
7/26/83		0			-			0
7/27/83					-			0
7128/83		0			-			0
7129/83		0			-			0
7/30/83	0				-			0
7/31/83	0				-			0
7/1/83		0	0		-			0
8/2/83				1	-			1
8/3183			13		50			63
8/4/83			0		-			0
8/5/83					-			0
8/6/83					-			0
8/7183					-			0
8/8183					-	0		0
8/9/83					-		1	1
8/10/83					-			0
8/11/83	0	7			-			7
8/12/83					-			0
8/13/83					-			0
8/14/83					-			0
8/15/83			0		-			0
8/16/83				0	-			0
8/17/83	0				-			0
8/18/83				1	-			1
8/19/83	0			0	-			0
8/20/83		1		0	-			1
8/21/83					-			0
8/22/83		0		0	-			0
8/23/83		0			-		0	0
8/24/83		1			-			1
8/25/63	0			4	-			4
8/26/83				0	-	2		2
8/27/83					-			0
8/28183					0			0
8/29/83	0			2	-	1		3
8/30/83				0	-			0
8/31/83					-			0
9/1/83	-	2	-	-	-	-	-	7
Total	0	11	13	18	50	3	1	96

Gill Nets Species: Arctic Flounder

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/8	Total
75																			0
80																			0
85																			0
90																2			2
95																1			1
100																1			1
105																2			2
110																2			2
115																3			3
120																3			3
125																			0
130																			0
135																			0
140																			0
145																4			4
150																3			3
155					1											3			4
160																2			3
165					2											6			8
170					1											4			5
175					1											2			3
180					1											5			6
185																5			5
190																1			1
195																			0
200																3			3
205					1											2			3
210					1											2			3
215																3			3
220																2			2
225															1	1			2
230																1			1
235																			0
240					1														1
Total		0	0	0	9	0	1	0	0	0	0	0	0	0	1	63	0	0	74

Gill Nets Species: Arctic Flounder

Date(M/D) Length (mm)	8/9	8/11	8/15	8/16	8/17	8/18	8/19	8/20	8/22	8/23	8/24	8/25	8/26	8/28	8/29	8/30	9/1	Total	Grand Total
75															1			1	1
80													1					1	1
85													1					1	1
90								1							1			2	4
95																		0	1
100		1																2	3
105		1																1	3
110																		0	2
115		1																1	4
120		1																1	4
125																		0	o
130																		0	0
135																		0	0
140																		0	0
145																		0	4
150																		0	3
155																		0	4
160		2																2	5
165																		2	10
170		1																1	6
175																		0	3
180																		0	6
185												1						1	6
190												1			1			2	3
195												2						2	2
200																		0	3
205																		0	3
210																		0	3
215																		0	3
220																		0	2
225																		0	2
230																		0	1
235																		0	0
240																		0	1
Total	1	7	0	0	o	1	0	1	o	0	1	4	2	0	3	o	0	20	94

Gill Nets **Species: Fourhorn Sculpin**

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/8	Total
85																			0
90																			0
95																1			1
100																		1	1
105																2			2
110																3			3
115														1		5			6
120																6			6
125																2			2
130																			0
135																			0
140																			0
145															1	3			4
150																2			2
155																2			2
160																4			4
165																4			4
170																7		1	8
175														1		4			6
180																1			1
185														1		1			2
190																2			2
195															1	2			3
200																3			3
205																3			3
210																3			3
215																1			1
220							1									2			3
225					1											2			3
230																			0
235																2			2
240							1												1
245																1			1
250							1								1				2
255																1			1
260																1			1
265																2			2
270																			0
275																1			1
280																2			2
Total	0	0	0	0	1	0	4	0	0	0	0	0	0	3	3	75	0	2	88

Gill Nets **Species: Fourhorn Sculpin**

Date(M/D) Length(mm)	8/9	8/11	8/15	8/16	8/17	8/18	8/19	8/20	8/22	8/23	8/24	8/25	8/26	8/28	B x a B L I Q s L u -			Total	Grand Total
85												1						1	1
90																		0	0
95																1		1	2
100									1				2					3	4
105	1														1			2	4
110	1										1		1					4	7
115		1								1			3					5	11
120	3									1	1							5	11
125										1			1					2	4
130	1														2			3	3
135											1					1		2	2
140										2	2							4	4
145										1			1					2	6
150													1					1	3
155	1					1					1		1					4	6
160									5		2		1					8	12
165	1	2								2	2							7	11
170									1	2	1		2		1			7	15
175	3	3																6	12
180		2	1							2								5	6
105		2	1															3	5
190	1	1																2	4
195	1										1							2	5
200																		0	3
205																		0	3
210		2										1			1			4	7
215																		0	i
220										1								1	4
225	3																	3	6
230						1									1			2	2
235																		0	2
240	1																	1	2
245																		0	1
250																		0	2
255																		0	1
260													1					1	2
265																		0	2
270																		0	0
275																		0	1
28o																		0	2
Total	17	13	3	0	0	2	0	0	7	13	12	2	14	0	6	2	0	91	179

Gill Nets **Species: Pacific** Herring

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/8	Total
120																			0
125																			0
130																			0
135																			0
140																			0
145																			0
150																			0
155																			0
160																			0
165																			0
170																			0
175																			0
180																			0
185																			0
190																			0
195																			0
200																			0
205																			0
210																			0
215																			0
220																			0
225																			0
230																			0
235																1		1	2
240																		1	1
245																4			4
250														1		2		1	4
255																1	1	1	3
260																1			1
265																4	1	1	6
270																			0
275																			0
280																			0
285																			0
290																			0
295																			0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	13	2	5	21

Gill Nets Species: Pacific Herring

Date(M/D)	8/9	8/11	8/15	8/16	8/17	8/18	8/19	8/20	8/22	8/23	8/24	8/25	8/26	8/28	8/29	8/30	9/1	Total	Grand Total
Length(mm)																			
120									1									1	1
125																		0	0
130																		0	0
135																		0	0
140																		0	0
145																		0	0
150																		0	0
155																		0	0
160																		0	0
165																		0	0
170																		0	0
175																		0	0
180																		0	0
185																		0	0
190																		0	0
195																		0	0
200																		0	0
205																		1	1
210			4					4	2	1			3					14	14
215						1		2		1			1					5	5
220	1	1						5	1	3		1	5					17	17
225						1		2		1			1					6	6
230		2	4			1		4	3	5	2		3					24	24
235	2	2	6			1			2	7	1		1					22	24
240	2		13			1		4	11	7	1		1					40	41
245	6	3	16			1			1	9	1	1	6					44	48
250	5	1	11			1		7	5	7		1	5		1			44	48
255	13	5	22			2		1		4	1	4	2		2			56	59
260	9	10	19	1		3		6	2	8	2	2	7		2			71	72
265	6	7	3			3	1			7	5	2	3					37	43
270	5	9	11			3		3	1	6	2		1					41	41
275	8	2	6							4	2							22	22
280		4	7						1	2		2						16	16
285										2								2	2
290	1	1																2	2
295								1										1	1
Total	58	48	122	1	0	18	1	39	30	74	17	13	39	0	6	0	0	466	487

Gill Nets **Species: Boreal Smelt**

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/8	Total
120																			0
125																			0
130																			0
135																			0
140																			0
145																			0
150																			0
155																1			1
160																			0
165																1			1
170																			0
175																			0
180																1			1
185																			0
190																			0
195																			0
200																1			1
205																1			1
210															1				1
215															2	2			4
220																4			4
225					1											1		1	3
230																			0
235																			0
240																1			1
245																2			2
250															1	1			2
255																1			1
260																2			2
265																1			1
270					1														1
2-l5																			0
280																			0
285																			0
290																			0
295																			0
300																			0
Total	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	20	0	1	27

Gill Nets **Species: Boreal Smelt**

Rate(M/D) Length(mm)	8/9	8/11	8/15	8/16	8/17	8/18	8/19	8/20	8/22	8/23	8/24	8/25	8/26	8/28	8/29	8/30	9/1	Total	Grand Total
120													1					1	1
125																		0	0
130																		0	0
135																		0	0
140																		0	0
145													1					1	1
150																		0	0
155																		0	1
160																		0	0
165													1					1	2
170												1						1	1
175																		0	0
180																		0	1
105													1					1	1
190																		0	0
195																		0	0
200								2		1								3	4
205																		0	1
210								1		3	1		1					6	7
215	1								3	5			1					10	14
220	3							1	28	5		1	1					39	43
225								1	1	7			4					13	16
230	9							1	24	7			3					44	44
235										3								3	3
240	3									5								8	9
245										3								3	5
250	3									1								4	6
255	1								1									2	3
260								1										1	3
265	3																	3	4
270										1								1	2
275										1								1	1
280																		0	0
285																		0	0
290																		0	0
295																		0	0
300	1																	1	1
Total	24	0	0	0	0	0	0	7	57	42	1	2	14	0	0	0	0	147	174

Fyke Net (Ocean) Species: Arctic Cod

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	Total
40														1					1
45	1																		1
50	2	5	1	2	2				1										13
55	1	1	8	16	8	11			3				1	1	1		1		52
60	13	12	4	20	18	7			17				1				4		96
65	17	6	14	21	14	13			35				2		1		4		127
70	13	9	10	36	32	10			27			2	1	1	2		14		157
75	18	16	10	41	17	22			42			5			1	2	13		187
80	21	12	7	26	25	21			16			17	2	1			10		158
85	10	18	11	18	13	23			18			15	11				3		140
90	6	36	8	7	10	5			6			19	8				6		111
95	7	14	8	6	7	6			4			13	6	1			2		74
100	3	21	12	2	12	5			1			12	5	1	1		4		79
105	3	3	1		2	2			2			3	1				1		18
110	2	7	3		1	5						1	4	1					24
115		1	1	1					1				3	2			1		10
120		2	1	1	1				1			2	1	5		2	1		17
125		1		1					1					3					6
130												2	1	5	1	4			13
135												1	3	2	4	6			16
140												1	2	1	1	2	1		8
145													3	1	2	8	1		15
150												1	3	1		5			10
155	1								1			1				5			8
160															1	15			16
165												1	4			9			14
170													2			5			7
175	1															2			3
180																3			3
185									1			1	1			6			9
190												1	1	1		2			5
195												1				3			4
200																2			2
205																1			1
210																			0
215																			0
220												1							1
225																			0
230																1			1
235																			0
240																			0
245																			0
250																			0
255																			0
260																			0
265																			0
Total	119	164	99	198	162	130	0	0	177	0	0	100	66	28	15	83	66	0	1407

Fyke Net (Lagoon) Species:Arctic Cod

Date(M/D) Length(mm)	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	Total	Grand Total
40														0	1
45														0	1
50														0	13
55														0	52
60	1													1	97
65														0	127
70	1												2	3	160
75	2												1	3	190
80	6							1		2			3	12	170
85	11			2						2			5	20	160
90	5	6		2		4	2	5		3	3		1	31	142
95	20	2		7		6	1	12		9			4	61	135
100	10	7		3		4	4	3		9				40	119
105	14	6		11			5	6					4	46	64
110	9	3		3		1	3	7		22	1		4	53	77
115	15	3		2		1	2	5			1	1	3	33	43
120				1		1	1	3			1		2	9	26
125	4	1				3							2	10	16
130	1	1				1	1	1						5	18
135	5	1		2		3	1						1	13	29
140	1	2		1			3			1			1	9	17
145	3			1		2	1	1		1				9	24
150	2	1		2			1	1						7	17
155		1		2		3		2						8	16
160	4	1		4		2				1				12	28
165	1	2		3		1	2	2					1	12	26
170	4	3		1		1				1				10	17
175		2		4		6	2							14	17
180	1	1					2							4	7
185								1					1	2	11
190	2	3		2		1								a	13
195										1				1	5
200						2								2	4
205				1										1	2
210		1												1	1
215		1		1										2	2
220						1								1	2
225														0	0
230														0	1
235														0	0
240														0	0
245														0	0
250														0	0
255		1												1	1
260														0	0
265		3												3	3
Total	122	52	0	55	0	43	31	50	0	52	6	1	35	447	1854

Fyke Net (Ocean) Species: Fourhorn Sculpin

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	Total
35																			0
40																			0
45			2		1														3
50	2	1	25	10	11	1										5	2		57
55	10		26	20	27	37			2				5		1	2	1		131
60	10	107	16	46	45	33			2				2		10	1	4		276
65	2	5	7	17	20	21			2				1		5	1			81
70	1	3	5	14	18	7							1		4	2	1		56
75	3	1		4	3	3			1				1		1	1	4		22
80	1			1	1	3									2	1			9
85																			0
90			1	1												1			3
95																			0
100			1						1						1		1		4
105				1											3		6		11
110			1			1									2	2	4		11
115			1												2		1		4
120	1														3	1	5		10
125															2	3	3		8
130															1	2	5		8
135													1		1	1	3		6
140																2	1		3
145															2	1	2		5
150																	3		3
155		1				1							1		3	1	2		9
160															1	4	3		8
165																3	3		6
170									1						1	2	2		6
175						1									1	6	1		9
180																4	3		8
185															1		2		3
190				1					1						2	1	1		6
195			1												2		4		7
200		2		1								1			1	1	2		8
205				1															1
210									1			1				2			4
215																1	1		2
220					1				2			2				2			7
225		1											1						2
230				1					1						1				3
235															1				1
240									1			1							2
245									1										1
250																	1		1
255																			0
260																			0
265				1															1
Total	30	121	86	119	127	108	0	0	16	0	0	5	16	0	54	53	71	0	806

Fyke Net (Lagoon) **Species: Fourhorn Sculpin**

Date(M/D) Length(mm)	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	Total	Grand Total
35												1		1	1
40														0	0
45												2		2	5
50										1	2	1		4	61
55										8	14	5	1	28	159
60						1				9	12	9	2	33	309
65						1				4 .	4		4	13	94
70				2		1				2	1	1	1	8	64
75		1		2		1	1			2	1	1	2	11	33
80		7		4		5	1	8		1	4	5	1	36	45
85		4		9		5	1	2		5	1	2	6	35	35
90		9		8		3	7	7		5	8		1	48	51
95		6		3		3	3	1		4	1	6		27	27
100		5		3		2	3	3		1	1		2	20	24
105						2		1			1	1	2	7	18
110		2		3		1	2					1	1	10	21
115		3					2	1				1	1	8	12
120		2		2		1	1	3		1	1			11	21
125		2		2		3	1	3				1	2	14	22
130		1		2		4	1	1		1	1	1	1	13	21
135				3		5	2	4				2	6	22	28
140		3		1		2	2	2		2		1	2	15	18
145		1						7		2		2	2	14	19
150		1		2		2	3	1		1	1	2	2	15	18
155						1		3				1	1	6	15
160		1										1	1	3	11
165		1		1		1	1							4	10
170						1								1	7
175							1						2	3	12
180				1								1		2	10
185		1		1									1	3	6
190							1	1						2	8
195														0	7
200		1												1	9
205													1	1	2
210						1							1	2	6
215												1	1	3	5
220														0	7
225														0	2
230								1					1	2	5
235								1						1	2
240														0	2
245														0	1
250														0	1
255														0	0
260														0	0
265														0	1
Total	0	51	0	50	0	46	33	50	0	49	53	49	48	429	1235

Fyke Net (Ocean) Species: Arctic Flounder

Date(M/D). Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	Total
30		3				1			1										5
35		3	1	1	2	9			1										17
40	1	10	1	3	3	5			1										24
45		10	3	1	10	5			1										30
50		4			4														8
55		1		1															2
60																			0
65		2			2	4			1										9
70		1		2	2	4									1				10
75		3		4	2	2			2			1	1						15
80				3	5	1									4		1		14
85		1		2	3	1							1		3				11
90				6	2	3									3	2	2		18
95		2		1	2	4						1			4	1	4		19
100		2		6	4	2									6		2		22
105		1		6	4	4			2						2	3	5		27
110		1	1	4	7	2			1					1	3	2	2		24
115		1		5	2	5			1			1			5	2	2		24
120			1	6	3	3			1						5	3	4		26
125		1	1	7	4	3			1			2	2	1	7	2	7		38
130	1		1	8	9	4			1			2		3	5		8		42
135		1	1	6	2	4			2			1		5	5		6		33
140		4	3	5	8	4			1			9		3	5	1	2		45
145		3		5	7	3			1			3		2	1	1	2		28
150	1	2		6	5	1			2			7	1	3	2		3		33
155		2		4	2	2			6			4	1	3		2	4		30
160		1		6	3	4			5			4	1	1		3	3		31
165	1	1		6	1	1			2			3	2	3	1	1	1		23
170		2	4	4	3	3			2			11		3		2			34
175		1	2	4	3	2			6			3	2				2		25
180		1		3					2			2	1	5		1			15
185			1	2	1	4			6			2		1					17
190	1	2		2					3					1	1				10
195			2	3	1	1						2	1	1					11
200			2						2			2					1		7
205			2		2				1			1				1	2		9
210			1	1	1				1			3							7
215						1													1
220									1										1
225		1										1							2
230																			0
235																			0
240																			0
Total	5	67	27	123	109	92	0	0	57	0	0	65	13	36	63	27	63	0	747

Fyke Net (Lagoon) Species: **Arctic** Flounder

Date(M/D) Length(mm)	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	Total	Grand Total
30										1				1	6
35										2				2	19
40														0	24
45														0	30
50														0	8
55														0	2
60														0	0
65														0	9
70	1									5		1		7	17
75	3	1						1		6			1	12	27
80										1			1	2	16
85	2	3		1									3	9	20
90	1	3								2				6	24
95	3	3		1				2		5				14	33
100	1	3		1						1				6	28
105		2								3				6	33
110		4		1										5	29
115		1												1	25
120		1				1		2		2				7	33
125		2								1			1	4	42
130						1								1	43
135						1		1		1			1	4	37
140	2	1				2		2		1			1	9	54
145						1		1		1				3	31
150		1				1		1						3	36
155		3				3		1		1				8	38
160	1	4				2		1		1				9	40
165		2								1				3	26
170		1				2				1				4	38
175		2								1			1	4	29
180		3				1				1				5	20
185	1	1		1		1	1			1				6	23
190	1			2						1				4	14
195		2		2		1		1		2				a	19
200		2		2		3		1						8	15
205		1				1	1	1					1	5	14
210		1				1		1		2				5	12
215	1			2		1				2			1	7	8
220		1						2						3	4
225		1		2		1								4	6
230		1		1										2	2
235														1	1
240						1								1	1
Total	18	50	0	17	0	25	2	18	0	46	0	2	11	189	936

Fyke Net (Ocean)   Species: Saffron Cod

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	Total
45																			0
50																			0
55																			0
60																			0
65																			0
70																			0
75																			0
80															2				2
85									2						1				3
90									2						3		1		6
95									4						6		7		7
100									7						24		1		2
105						1			3						13				0
110						1			1					1	8		2		1
115						3			1						3				7
120									3						1				5
125									1										1
130																			0
135																			0
140																			0
145																			
150																			0
155																			0
160																			0
165																			0
170																			0
175																			0
180																			0
185																			0
190																			0
195																			
200																			0
205																			0
210																			0
215																			0
220																			0
225																			0
230																			0
235																			0
240																			
245																			O
250																			o
255																			o
260																1			-
Total	0	0	0		0	5	0	0	2	0	0	0	0		61	1	2	0	0

Fyke Net (Lagoon) **Species:** Saffron Cod

Date(M/D) Length(mm)	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	Total	Grand Total
45							1							1	1
50										3				3	3
55										2			1	3	3
60										2			1	3	3
65										2	2		1	5	5
70										3			1	4	4
75													1	1	1
80														0	2
85														0	3
90		1				2				1				4	10
95				1						1				2	19
100		1				1		3		5	1			11	43
105		1		1		1		3		8				14	34
110		1				1		1		6				9	20
115		1		1		3		5		1			1	12	19
120		4		2		1		7		7				21	26
125		1				3		5		1				10	11
130		2		2		2		1						7	7
135		2		3		2		1						8	8
140		2		1		2		3		1				9	9
145		2				2	1							5	5
150		1		2		2								5	5
155		1		3		4								8	8
160		1		1		1								3	3
165		1		2										3	3
170				1										1	1
175						1								1	1
180				1										1	1
185						1								1	1
190														0	0
195														0	0
200														0	0
205														0	0
210														0	0
215														0	0
220														0	0
225														0	0
230														0	0
235														0	0
240														0	0
245														0	0
250														0	0
255														0	0
260														0	1
Total	0	22	0	21	0	29	2	29	0	43	3	0	6	155	260

Fyke Net (Ocean) Species: Boreal Smelt

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	Total
50																			0
55																			0
60																			0
65																			0
70																			0
75																			0
80																			0
85																			0
90																			0
95																			0
100																			. -
105																			0
110																			0
115																			0
120																			0
125																			0
130																			0
135																			0
140																			0
145																			0
150																			0
155																			0
160																			0
165																			0
170																			0
175																			0
180																			0
185																			0
190																			0
195																			0
200																			0
205																			0
210																			0
215																			0
220																			0
225																			0
230																			0
235																			0
240																			0
245																			0
250																			0
255																			0
260																			0
265																			0
270																			0
Total	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Fyke Net (Lagoon) Species: Boreal Smelt

Date(M/D)	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	Total	Grand Total
Length(mm)															
50										1				1	1
55										3				3	3
60										9	1			10	10
65										4				4	4
70										3	1	1	1	6	6
75														0	0
80														0	0
85							1			1				2	2
90							6			3				9	9
95							3			4	2	1		10	10
100	1						7			7		1		16	17
105		1					7			4	1			13	13
110		1					11			4	1			17	17
115		2					4			1				7	7
120							3							3	3
125							1							1	1
130														0	0
135														0	0
140														0	0
145							1	1						2	2
150								1						1	1
155														0	0
160														0	0
165								1						2	2
170														0	0
175														0	0
180														0	0
185														0	0
190														0	0
195		1												1	1
200								1						1	1
205														0	0
210	1	1												2	2
215				1										1	1
220	2	1						1						4	4
225	1	2												3	3
230		1				1								2	2
235	1	1				1								3	3
?40		1												2	2
245		2				1								3	3
250														0	0
255		1												1	1
260	1													1	1
265														0	0
270	1					1								2	2
Total	8	16	0	1	0	4	44	6	0	44	6	3	1	133	134

Fyke Net (Ocean) Species: Capelin

Date(M/D) Length(mm)	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	Total
110																2			2
115																3	1		4
120															6	5	6		17
125															10	17	11		38
130												1	1		18	12	12		44
135															16	9	13		38
140															4	6	10		20
145															2	2	6		10
150															1				1
155																1	1		2
Total	0	0	0	0	0	0	0	0	0	0	0	1	1	0	57	57	60	0	176

Fyke Net (Lagoon) Species: Capelin

Date(M/D) Length(mm)	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	Total	Grand Total
110														0	2
115														0	4
120														0	17
125													1	1	39
130														0	44
135														0	38
140														0	20
145														0	10
150														0	1
155														0	2
Total		0	0	0	0	0	0	0	0	0	0	0	1	1	177

10.5 Fish Catch and Effort Listings (*Discoverer* Cruise)

This section contains fishing effort and catch data by gear type for the 1983 *Discoverer* cruise sampling effort. Actual catch by species is listed for each station.

Geographic Coordinates/Depth: Otter Trawls

Station	Date	Latitude	Longitude-	Depth (m)
1	27/08/83	69°47´N	163 16-N	17
3	28/08183	69°45´N	163 19´N	17
4	30108/83	70° 7´N	165 24-N	42
5	30/08/83	70°10´N	165 34-N	43
6	30108/83	69°52´N	164 4´N	29
7	31/08/83	69°50´N	163 33´N	23
8	31/08/83	69°47´N	163 15´N	15
9	31/08/83	69°45´N	163 4"N	13
10	31/08/83	69°46´N	163 4-N	13
11	31/08/83	69°46´N	163 4´N	13
12	1/09/83	70° 9N	162 45-N	18
13	1/09/83	70°33´N	160 33-N	20
14	1/09/83	70031-N	160 34-N	17
1 6	2/09/83	70 39"N	160 llN	20
17	2/09/83	70°40´N	160 17-N	24
18	2/09/83	70° 42´N	160 30´N	42
20	8/09/83	69; 45"N	167 29-N	48
21	10/09/83	69° l-N	165 35"N	21
22	10/09/83	69°11´N	165 40-N	30
23	10/09/63	68 52"N	165 28-N	7
25	11/'09/83	68°52´N	165 27-N	7
26	11/09/83	680 56"N	165 28-N	7
27	11/09/83	6904 0´N	165 33-N	44
28	12/09/83	6805 0´N	166 23´N	31
29	12/09/83	68 1*N	166 I-N	26

Geographic Coordinates/Depth: Gill Nets

Station	Date	Latitude	Longitude	Depth (m)
1	29/08/83	69°45´N	163° 4´W	9
2	28/08/83	69°47´N	163° 16´W	18
3	28/08183	69°46´N	163° 6-W	13
4	31108/83	69°49´N	163" 29´W	23
5	30/08/83	69°52´N	163" 57´W	27
6	30/08/83	70° 6´N	165° 20-W	41
7	3109/83	70°38´N	160° 5´W	15
8	2/09/83	70°38´N	160° 5´W	15
9	3/09/83	70°40´N	160° 17´W	22
10	10/09183	68°51´N	165° 29´W	16
11	10/09/83	68°52´N	165033-W	10
12	10/09/83	68° 52°N	165° 28´W	10
13	11/09/83	69° 1´N	165° 33´W	22
14	11/09/83	69°11´N	165" 34-W	27

Effort Summary: Otter Trawls

Station	Gear Type	Km Trawled
1	25′	1.792
3	25′	1.755
4	25′	5.803
5	25′	4.525
6	25′	3.843
7	25′	4.146
8	25′	3.932
9	12′	.730
10	12′	.200
11	12′	.294
12	25′	3.081
13	25′	4.815
14	25′	2.949
16	25′	3.067
17	25′	2.246
18	25′	2.692
20	25′	1.502
21	25′	3.248
22	25′	4.284
23	12′	1.479
25	12′	1.353
26	12′	.608
27	25′	6.499
28	25′	1.710
29	25′	1.549

Effort Summary: Gill Nets

Station	Hours Fished
1s	44
1B	44
2s	36
2B	36
3s	39
3B	39
4s	19
4B	19
5s	14
5B	14
6S	15
6B	15
7s	26
7B	26
8s	22
8B	22
9s	24
9B	24
10s	18
10B	18
11s	18
11B	18
12s	16
12B	16
13s	19
13B	19
14s	18
14B	18

Catch Summary: Otter trawl, Spe ies by Station

Species	Station 1[1]	3[1]	⟼	5[2]	6	7	8[3]	9	10	11	12[4]	13[1]	14	16[a]	Total
Arctic staghorn sculpin (*Gymnocanthus tricuspis*)	566	665	28	11	63	22	73	16	31	10	366	14	4	3	1872
Arctic cod (*Boreogadus saida*)	100	106	247	96	136	171	121	9	9	0	6	78	4	6	1089
Hamecon (*Artediellus scaber*)	5	11	0	0	4	2	21	3	1	12	1	12	0	2	124
Shorthorn sculpin (*Myoxocephalus scorpius*)	55	65	1	2	.0	64	22	0	0	1	26	7	4	1	308
Saffron cod (*Eleginus gracilis*)	.02	2	0	0	1	0	0	1	0	0	8	1	1	0	16
Slender eelblenny (*Lumpenus fabricii*)	12	1	0	0	3	2	4	0	0	0	2	3	2	0	29
Ribbed sculpin (*Triglops pingeli*)	3	1	0	0	4	56	10	0	0	0	0	5	0	0	79
Snailfish (*Liparis spp.*)	1	6	0	0	0	15	3	3	9	2	1	0	0	0	50
Yellowfin sole (*Limanda aspera*)	2	1	1	0	0	1	0	0		0	2	0	0	0	8
Sand lance (*Ammodytes hexapterus*)	8	2	0	0	0	3	6	0	.	0	2	0	0	0	21
Walleye pollock (*Theragra chalcogramma*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sturgeon seapoacher (*Agonus acipenserinus*	4	6	0	0	0	0	6	0	0	0	2	0	0	0	18
Antlered sculpin (*Enophrys diceraus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic shanny (*Stichaeus punctatus*)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Arctic alligatorfish (*Asidophoroides olriki*)	0	0	0	0	2	3	0	0	0	0	0	1	0	0	6
Saddled eelpout (*Lycodes mucosus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	.	1
Fish doctor (*Gymnelis viridis*)	0	0	0	0	2	0	0	0	0	0	0	1	0	0	3
Eyeshade sculpin (*Nautichthys pribilovius*)	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
Arctic eelpout (*Lycodes reticulatus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fourhorn sculpin (*Myoxocephalus quadricornis*)	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4
Pacific herring (*Clupea harengus pallasii*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnelis hemifasciatus	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Polar eelpout (*Lycodes polaris*)	0	0	0		0	0	0	0	0	0	0	0	0	0	0
Fourline snakeblenny (*Eumesogrammus praecisus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whitespotted greenling (*Hexogrammos stelleri*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spatulate sculpin (*Icelus spatula*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Archer eelpout (*Lycodes sagittarius*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic flounder (*Liopsetta glacialis*)	0	0		0	0	0	0	0	0	0	0	0	0	0	0
Boreal smelt (*Osmerus mordax*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	858	866	277	109	238	342	266	32	15	25	416	123	15	13	3635

Catch Summary: Otter trawl, Species by Station

Species	Station 17	18[3]	20	21	22[1]	23	25	26	27	28	29[3]	Total	Grand Total
Arctic staghorn sculpin (*Gymnocanthus tricuspis*)	43	7	0	530	91	24	11	215	18	2	3	944	2816
Arctic cod (*Boreogadus saida*)	12	15	162	158	13	1	0	0	808	3	0	1172	2261
Hamecon (*Artediellus scaber*)	531	31	42	5	9	2	62	5	0	1	20	708	832
Shorthorn sculpin (*Myoxocephalus scorpius*)	156	6	8	41	12	7	9	98	1	5	21	364	672
Saffron cod (*Eleginus gracilis*)	0	0	0	216	98	13	4	18	0	15	59	423	439
Slender eelblenny (*Lumpenus fabricii*)	1	0	0	112	61	2	1	0	25	4	3	209	238
Ribbed sculpin (*Triglops pingeli*)	40	36	8	3	1	0	1	3	0	9	2	103	182
Snailfish (*Liparis spp.*)	7	0	3	0	1	0	1	0	1	0	1	14	64
Yellowfin sole (*Limanda aspera*)	1	0	1	25	1	0	5	2	0	1	0	36	44
Sand lance (*Ammodytes hexapterus*)	0	0	0	15	0	0	0	0	0	2	0	17	38
Walleye pollock (*Theragra chalcogramma*)	0	0	1	0	4	0	0	0	0	10	13	28	28
Sturgeon seapoacher (*Agonus acipenserinus*)	0	0	0	4	0	0	0	2	0	0	0	6	24
Antlered sculpin (*Enophrys diceraus*)	0	0	0	0	0	0	0	0	0	0	20	20	20
Arctic shanny (*Stichaeus punctatus*)	0	0	0	0	0	0	0	0	0	3	14	17	18
Arctic alligatorfish (*Asidophoroides olriki*)	0	0	7	0	0	0	1	0	0	1	0	9	15
Saddled eelpout (*Lycodes mucosus*)	5	1	5	0	1	0	0	0	0	0	0	12	13
Fish doctor (*Gymnelis viridis*)	0	2	1	0	0	0	0	0	0	0	5	8	11
Eyeshade sculpin (*Nautichthys pribilovius*)	1	1	0	0	0	0	0	0	0	0	0	2	5
Arctic eelpout (*Lycodes reticulatus*)	0	0	3	0	0	0	0	0	2	0	0	5	5
Fourhorn sculpin (*Myoxocephalus quadricornis*)	0	0	0	0	0	0	0	0	0	0	0	0	4
Pacific herring (*Clupea harengus pallasii*)	0	0	0	0	0	0	0	0	0	4	0	4	4
Gymnelis hemifasciatus	0	0	0	0	0	0	0	0	0	0	0	0	3
Polar eelpout (*Lycodes polaris*)	0	0	0	0	0	0	0	0	3	0	0	3	3
Fourline snakeblenny (*Eumesogrammus praecisus*)	0	0	2	0	0	0	0	0	0	0	0	2	2
Whitespotted greenling (*Hexogrammos stelleri*)	0	0	0	1	0	0	0	0	0	0	1	2	2
Spatulate sculpin (*Icelus spatula*)	0	1	0	0	0	0	0	0	0	0	0	1	1
Archer eelpout (*Lycodes sagittarius*)	0	0	0	0	0	0	0	0	1	o	0	1	1
Arctic flounder (*Liopsetta glacialis*)	0		0	0	0	0	0	0	1	o	0	1	1
Boreal smelt (*Osmerus mordax*)	0	1	0	1	0	0	0	0	0	0	0	1	1
	797	100	243	1111	292	49	95	343	860	60	162	4112	7747

[1] 20% subsample
[2] 30% subsample
[3] 25$ subsample
[4] 10% subsample

Catch Summary: Gill nets, Species by Station

Species	Station 1S	1B	2S	2B	3S	3B	4S	4B	5S	5B	6S	6B	7S	7B	Total
Pacific herring (*Clupea harengus pallasii*)	2	4	0	0	1	1	0	1	0	0	1	0	1	1	12
Boreal smelt (*Osmerus mordax*)	2	1	0	0	0	0	0	0	0	0	0	0	7	2	1	31
Fourhorn sculpin (*Myoxocephalus quadricornis*)	0	0	0	0	0	0	0	0	0	0	0	0	1	9	10
Shorthorn sculpin (*Myoxocephalus scorpius*)	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Arctic cod (*Boreogadus saida*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Longhead dab (*Limanda proboscidea*)	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Arctic char (*Salvelinus alpinus*)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Arctic flounder (*Liopsetta glacialis*)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Alaska plaice (*Pleuronectes quadrituberculatus*)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	4	9	0	0	2	1	0	1	0	0	1	0	9	33	60

Catch Summary: Gill nets, Species by Station

Species	Station 8S	8B	9S	9B	10S	10B	11S	11B	12S	12B	13S	13B	14S	14B	Total	Grand Total
Pacific herring (*Clupea harengus pallasii*)	1	0	0	0	2	0	5	3	2	1	1	5	0	14	34	46
Boreal smelt (*Osmerus mordax*)	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	33
Fourhorn sculpin (*Myoxocephalus quadricornis*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Shorthorn sculpin (*Myoxocephalus scorpius*)	0	0	0	0	0	0	0	2	1	1	0	0	0	0	4	6
Arctic cod (*Boreogadus saida*)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
Longhead dab (*Limanda proboscidea*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Arctic char (*Salvelinus alpinus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Arctic flounder (*Liopsetta glacialis*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Alaska plaice (*Pleuronectes quadrituberculatus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	1	2	0	0	2	0	5	7	3	2	1	5	0	14	42	102

10.6 Length-frequency Data Listings (Discoverer Cruise)

This section shows length-frequency data for the most abundant species caught by otter trawl during the 1983 Discoverer cruise" Data is provided for the following species:

Otter Trawl
Arctic staghorn sculpin
Hamecon
Arctic cod
Shorthorn sculpin
Saffron cod
Ribbed sculpin
Slender eelblenny

Otter trawl : **Arctic** cod

Length(mm)	Station 1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
30	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
35	0	0	1	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
40	0	1	2	5	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33
45	0	2	4	9	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
50	0	2	1	9	7	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	22
55	1	0	0	0	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
60	6	4	0	2	5	3	0	0	0	0	1	3	2	0	2	0	0	0	0	0	0	0	0	0	0	28
65	13	5	1	5	9	9	2	1	0	0	1	4	0	0	3	0	0	0	0	0	0	0	0	0	0	53
70	11	15	3	3	10	13	3	0	2	0	0	5	1	1	2	1	3	0	0	0	0	0	0	0	0	73
75	16	13	11	8	7	13	9	1	0	0	0	9	0	0	3	1	8	0	0	0	0	0	3	0	0	102
80	14	10	13	15	8	12	15	1	1	0	0	5	0	2	1	1	13	2	0	0	0	0	5	0	0	118
85	10	20	9	14	2	17	20	1	1	0	0	10	0	0	0	3	20	7	3	0	0	0	10	0	0	147
90	7	14	9	8	4	17	18	1	2	0	1	19	1	0	0	5	14	12	0	0	0	0	13	0	0	145
95	6	11	10	2	5	8	5	3	0	0	0	5	0	0	0	1	13	21	2	1	0	0	19	1	0	113
100	3	7	5	3	3	2	1	0	3	0	0	4	0	1	0	0	7	25	3	0	0	0	14	1	0	82
105	1	2	2	0	1	1	1	0	0	0	0	2	0	0	0	2	6	15	3	0	0	0	6	0	0	42
110	0	0	4	1	0	3	1	0	0	0	0	2	0	1	0	1	1	11	2	0	0	0	8	0	0	35
115	0	0	1	2	0	0	2	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	2	0	0	13
120	0	0	3	1	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	4	0	0	12
125	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	7
130	0	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	9
135	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	1	1	0	8
140	0	0	3	1	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	1	0	0	9
145	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	3
150	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	2	0	0	9
155	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
16o	1	0	2	0	2	1	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	2	0	0	11
165	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
170	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3
175	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
180	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
185	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 -
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
215	“o	0	0	0	0	0	0	0	0	0	, 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	_ d L -	_ 9 -	0	0	0	1
	89	106	100	96	116	102	7	8	9 99	0	6	78	4	6	12	15	95	100	13	1	0	0	101	3	0	1139 ,

Otter trawl :Arotio staghorn sculpin

Station

Length(mm)	1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
25	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
30	0	1	9	8	4	0	3	0	0	0	2	0	1	1	2	0	0	3	3	0	0	1	0	0	1	39
35	5	1	2	3	12	2	2	0	0	0	17	1	0	0	3	0	0	12	0	0	0	2	8	0	0	70
40	43	19	5	0	14	9	8	0	0	0	57	4	1	2	21	3	0	2	24	0	0	6	1	0	0	219
45	32	44	9	0	3	7	1'7	1	0	0	21	4	2	0	16	2	0	24	0	0	0	4	0	0	0	186
50	13	25	1	0	6	3	21	1	2	0	9	3	0	0	1	0	0	38	33	1	0	3	1	4 0	0	192
55	6	4	0	0	15	1	3	1	3	0	0	1	0	0	0	0	0	7	3	9	0	33	4	0	0	90
60	3	0	1	0	3	0	1	0	1	1	4	0	0	0	0	0	0	3	1	7	3	1	2	0 0	0	40
65	5	3	0	0	2	0	5	4	3	2	0	0	0	0	0	0	0	7	4	6	3	0	0	0	0	44
70	7	6	0	0	2	0	7	2	11	0	0	0	0	0	0	0	0	6	8	0	1	3	0	1	1	55
75	2	0	0	0	0	0	3	3	5	3	1	1	0	0	0	0	0	5	7	0	0	5	1	0	0	36
80	0	1	1	0	0	0	1	4	4	2	0	0	0	0	0	0	0	4	1	0	1	3	0	0	0	22
85	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	2	0	1	0	0	0	0	7
90	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	2	1	2	0	0	0	0	8
95	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
100	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	5
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2
135	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
	118	105	28	11	63	22	?3	16	31	10	111	14	4	3	43	7	0	116	91	24	+	*	~	2-	3	1024

Otter trawl :Hamecon

Station

Length(mm)	1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0 0		1	0	0	0	0	3
25	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	3
30	29	5	0	0	0	0	1	0	0	0	1	4	0	1	46	3	0	0	0	0	0	0	0	0	0	90
35	1	8	5 0	0	1	0	7	0	0	0	0	0 0		0	4	0	0	0 2	3	0	1	0	0	0	5	82
40	4	1	0	0	3	0		3	0	1	1	0	0	0	0	0	11	10	0	1 1	0	16	2 o	0	0	54
45	2	0	0	0	0	1	3	1	0	1	0	2	0	0	7	9	1	0	1	0	10	1	1 0	1	1	41
50	1	0	0	0	0	1	5	0	0	5	0	1	0	1	1	3	3	0	2	0	16	0	0	0	2	41
55	0	0	0	0	0	0	1	2	0	2	0	3	0	0	1	3	6	0	2	1	11	1	0 0	0	6	39
60	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	1	4	0	0	1	7	1	0	0	3	23
65	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2	0	5	0	0	0	0	0	0	0	2	11
70	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	8	0	0	0	0	0	0	0	1	11
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	9
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	6
	55	11	0	0	4	2	2 1	3		1	12	1	12	0 2	112	31	42	5	9	2	6	2 5	0	1	20	413

Otter trawl :Shorthorn soulpin

Length(mm)	Station 1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
30	5	2	0	1	0	0	3	0	0	0	0	0	1	0	4	00	00	00	00	00	0	3	0	0	0	19
35	38	25	0	0	2	4	3	0	0	0	15	2	2	0	25	1	1	2	1	0	1	10	0	0	2	134
40	45	27	0	1	6	33	9	0	0	0	9	1	0	0	33	1	1	7	1	1	2	45	0	0	2	224
45	16	6	1	0	1	10	1	0	0	0	0	0	0	0	9	1	0	0	1	0	1	25	1	0	0	73
50	0	2	0	0	1	6	3	0	0	0	0	4	1	1	16	1	0	0	0	0	0	4	0	0	0	39
55	1	1	0	0	0	6	1	0	0	0	0	0	0	0	11	1	0	0	0	0	0	1	0	0	0	22
60	0	1	0	0	0	5	1	0	0	1	1	0	0	0	4	1	0	0	0	0	0	2	0	0	1	17
65	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	1	0	0	5	10
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	2	1	0	2	2	13
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	2	0	0	1	12
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	1	7
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	2	0	1	0	7
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	2
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	3
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1·	0	0	0	0	0	1	2	5
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
115	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	4
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	5
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	1	5
135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	4
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
1U5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
215	0	0	0	0	0	0		0	0	0	0		0		.	0	0	0	0	0	0	0	0	0	1	
	105	65	1	2	10	64	22	220	00	01	1		26	1	102	6	8	41	12	7	9	98	1	5	21	618

Otter trawl :Saffron cod

Station

Length(mm)	1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
45	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0 0	0 0	0 0	0 0	0 0	0	0	0	0	0 0	0	1
50	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5
55	1	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	12	0	0	0	1	0	3	7	28
60	1	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	40	11	0	1	2	0	4	24	87
65	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	24	40	2	1	5	0	2	11	86
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	26	4	1	7	0	0	7	63
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	11	5	1	1	0	4	2	31
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	2	0	1	0	2	2	14
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	2	5
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	4
95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	9 -	0	0	0	0	0	0	0	L -	0	0	0	0	0	0	1	1
	2	2	0	0	1	0	0	1	0	0	8	1	1	0	0	0	0	106	98	13	4	18	0	15	59	329

utter trawl :Slender eelblenny

Station

Length(mm)	1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	9
55	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	6	1	0	0	0	1	0	0	11
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	4
70	0	0	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	11	4	0	0	0	2	0	0	21
75	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	20	11	0	0	0	1	0	0	33
80	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	19	0	0	0	1	0	0	47
85	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	20	10	0	0	0	0	0	0	33
90	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	8	5	0	1	0	0	0	1	17
95	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	4	0	0	0	0	0	1	17
100	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	3	0	0	0	2	0	1	9
105	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
110	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	2	0	6
115	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
120	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	5
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
130	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1'	1	0	2
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	4
150	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
160	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	Q	1
	12	1	0	0	3	2	4	0	0	0	2	3	2	0	1	0	0	112	61	2	1	0	2	5 4	3	238

Otter trawl :Ribbed sculpin

Station

Length(mm)	1	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18	20	21	22	23	25	26	27	28	29	Total
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	7
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	0	0	4
50	1	0	0	0	3	0	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	1	0	0	0	14
55	1	0	0	0	1	5	0	0	0	0	0	0	0	0	9	9	0	0	0	0	0	0	0	0	0	25
60	0	0	0	0	0	10	0	0	0	0	0	1	0	0	11	11	0	0	0	0	0	0	0	0	0	33
65	1	1	0	0	0	22	1	0	0	0	0	2	0	0	2	2	0	0	0	0	0	0	0	3	0	34
10	0	0	0	0	0	15	4	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	3	0	24
75	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	11
80	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	5
90	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	4
95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	4
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2
105	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0.	0	0	0	0	0	2
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	1	1
130	0	0	0	0	0	0	0	0	0	0	0	Q	Q	0	L	0	1	0	0	0	0	0	0	0	1	2
	3	1	0	0	4	56	10	0	0	0	0	5	0	0	40	36	8	3	1	0	1	3	0	9	2	182

LGL
Ecological Research Associates
1410 Cavitt Street Bryan, Texas 77801
(409) 775-2000